FEBRUARY 1957

Power Engineering

This New Tester Shows Condensate Corrosion Patterns 67
Here's How To Investigate a Casualty 68
More D-C Power in Smaller Packages 72
Monitor for Peak Combustion Efficiency Measures O_2 74
How Soon Will We Get Fusion Power?—A Progress Report 75
What Does Cooling Tower Maintenance Cost? 79
Memphis Plans Big Power Program 82
APC Will Spotlight Power Engineering Progress 83
How To Check Condensate System Before Plant Start-Up 84
Modern Ash Handling Pays Off At Milliken Station 86
How Ammonia Compressors Can Make Dry Ice 89
Hot-Lime-Zeolite Still a Good Process for Many Plants 90
Does Your Cleaning Cost Too Much? 91
Another Pipe Sizing Chart—Simple, Accurate 92
Energy From The Sun—How We Put It To Work 94
Atomic Tool Measures Tube Thickness 98
You Can Increase Diesel Life With Proper Warm-Up 100

REGULAR DEPARTMENTS

Engineers' Preview 3
What They Tell Us 6
Helpful Bulletins 41
Construction News 52
Equipment News 54
News Reel 80
Power Engineering Handbook 106
New Engineering Books 118
Catalog Library 131
Reader Service Post Cards 131
Advertisers' Index 146
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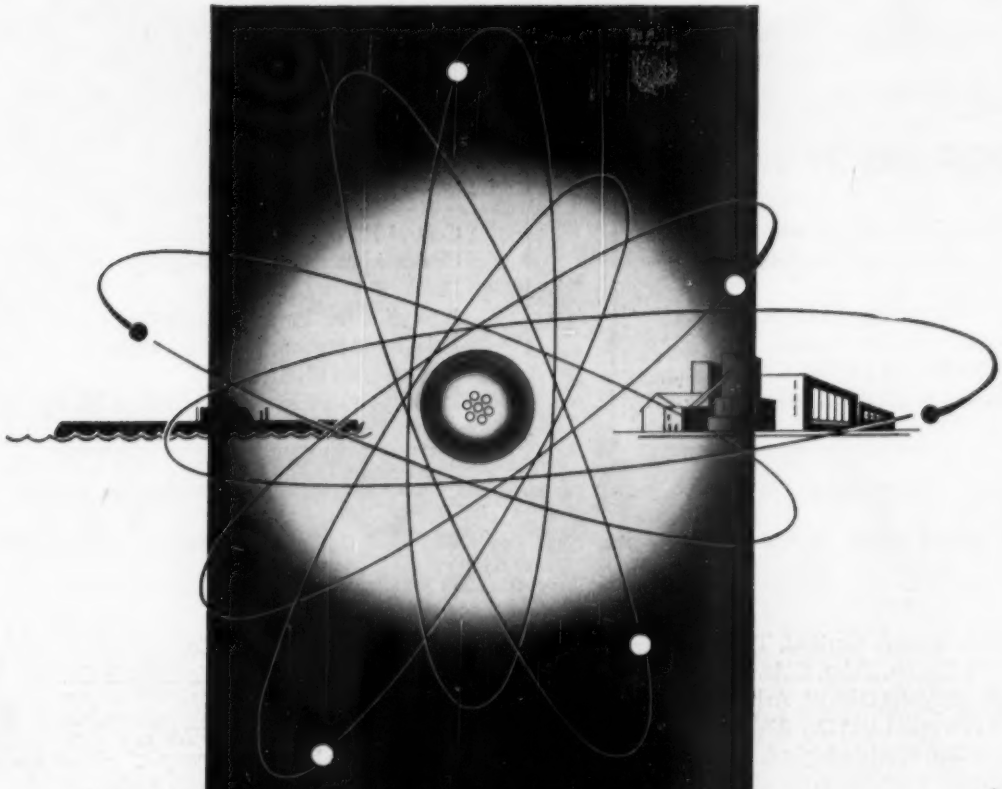

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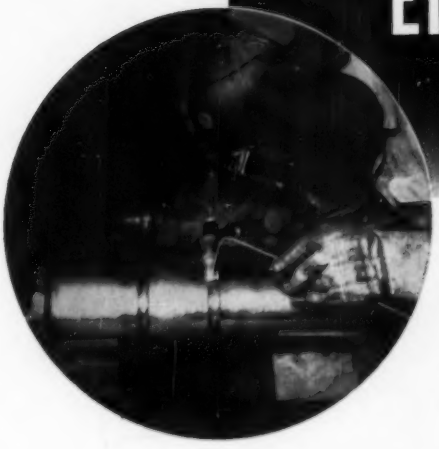

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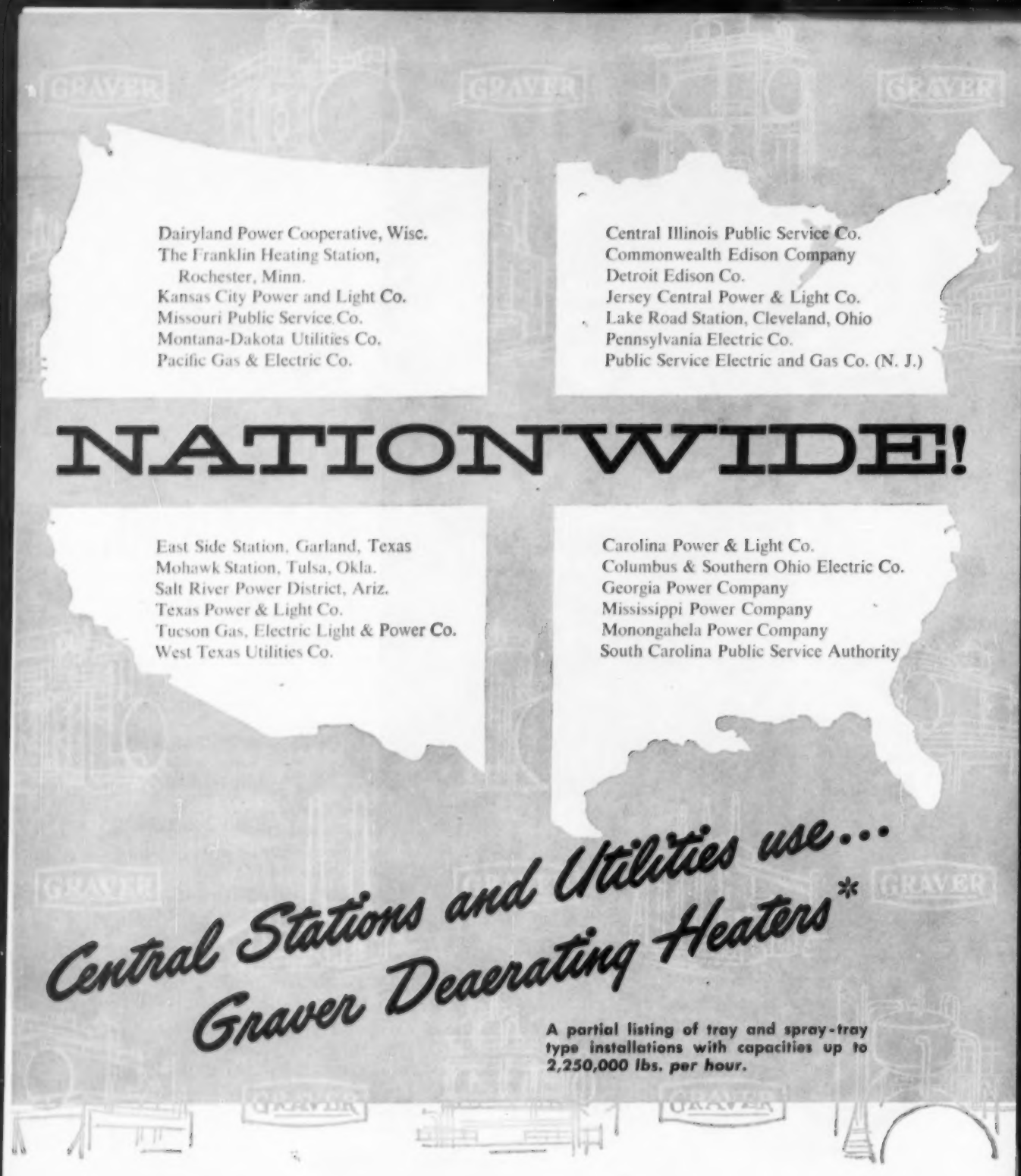
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ENGINEERS' PREVIEW

We Are Looking For Editors

POWER ENGINEERING is expanding and will have openings for graduate engineers in the mechanical or electrical field with a good solid background of operating, design, and construction experience. If you like to travel, meet people, learn of new developments, investigate new ideas, and if you have imagination, ingenuity and tact, together with a reasonable command of English, you will find this interesting work. There are several openings on the editorial staff, but the immediate one has the following specifications:

A graduate engineer from 45 to 50 years of age, who has gone through a cadet or student engineer's course with one of the public utilities, spent a number of years in the operating department, two or three years in the power sales department, and a number of years as power engineer with industrial companies, and who holds a professional engineer's license.

Another opening could be filled by a graduate engineer about 30 years old, with good grounding in engineering fundamentals, and particularly in heat power engineering. Subsequent to graduation, he should have had several years of work in a utility or industrial power plant, or in an industry having diversified steam and electrical problems.

If you meet all or many of the above specifications and are interested in the above jobs, send complete details of your education and experience to Editor of POWER ENGINEERING, 110 S. Dearborn St., Chicago, Ill. Mark your letter Personal or Confidential.

FORTY-FIVE high school teachers who are either currently giving instruction in science, or who are capable of being converted to science teaching, will study at Harvard University next year under a program made possible by a grant of $259,000 from the National Science Foundation. They will take courses in four major fields — mathematics, chemistry, biology and physics — which will be given by scientists in the faculty of Arts and Sciences, as well as education courses given by the Graduate School of Education. Fellows may also take other science courses if they wish. The grant to Harvard is one of 16 which the National Science Foundation, a Federal agency, is making to colleges and universities in this country in an effort to strengthen science teaching in secondary schools.

Recipients of these Fellowships at Harvard will each receive stipends of $3000 plus $300 allowances for each dependent up to four dependents, a $50 book allowance, and travel expenses up to $160. Under the program it is possible for a Fellow to receive as much as $4400, none of which will be spent on tuition.

FIRST power plant in the United States to be planned as a combined gas turbine-steam turbine generator unit will be built at Cordele, Georgia, by the Crisp County Power Commission, it was announced recently by W. Dan Sinclair, manager and chief engineer of the Commission.

In the new unit, exhaust from a gas turbine will flow into a steam boiler where, in combination with pulverized coal, it will produce steam for a steam turbine.

(*Editor's Note:* This is essentially the hook-up discussed and shown in Fig. 27, POWER ENGINEERING's Gas Turbine Primer, December 1955 issue.)

Although several other power stations are using gas turbines to improve efficiency of steam turbines, the Crisp County installation will be the first specifically designed and engineered to combine a gas turbine and steam turbine unit. Both the gas and the steam turbine-generators will be built by the General Electric Co.

The gas turbine, itself, will be built by the Gas Turbine Department in Schenectady, N. Y., and the generator to be attached to the gas turbine, as well as the entire steam

turbine-generator unit for the second part of the cycle, will come from the Medium Steam Turbine, Generator and Gear Department, Lynn, Mass.

In the new plant, a 5000-kw simple-cycle, single-shaft gas turbine will exhaust into a steam boiler to develop 600-psi 825-F steam for a 12,500-kw steam-turbine generator. Thus, the maximum capability of the combined cycle is estimated at 17,500 kw.

Pulverized coal will provide supplementary firing in the boiler to provide additional steam, including necessary superheat when required by the steam turbine, over that generated by the gas turbine to the capacity of the steam turbine. The steam boiler will have capacity for the full output of the steam turbine when the gas turbine is not operating. Natural gas will be used as fuel for the gas turbine.

DICK MORRIS (right), editorial director of POWER ENGINEERING and retiring president of the Society of Business Magazine Editors, congratulates the new president of the society, Bill Phair, editor of *Hardware Age*. After the election, Carroll Buzby, president of the Chilton Organization, wired: "Chilton is proud to learn of the honor which has come to Bill Phair and assures the society of continued support." Other new officers include: First vice president, Charlie Herb, *Machinery*; second vice president, Colin Carmichael, *Machine Design*; and secretary-treasurer, Frank Richter, *Modern Railroads*. POWER ENGINEERING is a charter member of the SBME, the only independent national professional organization of industrial magazine editors. The Circle and Quill, symbol of the society, is carried on our masthead on page 3.

TENTH ANNUAL Conference for Protective Relay Engineers will be held April 15-17, 1957, Department of Electrical Engineering, A & M College of Texas, College Station, Texas. For further information write L. M. Haupt, Conference Chairman, at that address.

CORRECTION NOTE — World Power Conference Papers: In our special report on the World Power Conference in Vienna, Austria, published in the September 1956 issue, a note on page S-12 stated that, except for the copies of the papers sent to each engineer who registered to attend the Conference, no other copies of the individual papers could be obtained. It was also stated that a complete set of the transactions, when published, would cost in the neighborhood of $50 or $55. That was the information we had when the article went to press.

Now, however, we learn from both Charles Gray, Secretary of the International Executive Council of WPC, and from Stewart E. Reimel, Secretary of the U. S. National Committee of WPC, that this situation has changed. On October 15, 1956, the Austrian National Committee announced that preprints of the individual papers and of the general reports would continue to be sold up to the date of publication of the bound transactions at the latest — the price being Austrian schillings 0.40 per printed page — mailing charges extra. We also learn from Mr. Reimel that the price mentioned was that for previous sets of the transactions, which usually ran to 4 or 5 volumes. However, the Vienna Conference transactions are being published in 20 volumes and will be sold at cost plus handling charges; the total will be in the neighborhood of $165. Accordingly, readers interested in obtaining individual papers or placing advance orders for complete transactions can do so most conveniently through Stewart E. Reimel, Secretary, U. S. National Committee, World Power Conference, c/o Engineers Joint Council, 29 West 39th Street, New York 18, New York.

WORKING with invisible iron dust, General Electric researchers have created a revolutionary and potentially super-strong magnet. Theoretically, the ultra-fine particle iron magnet can be made ten times stronger than the best available magnets. Already experimental magnets have been made equal to the strongest commercial magnets.

The new magnet will result in electric instruments that are smaller, lighter, more accurate and more rugged, making possible significant advances in instrumentation, although it will be quite some time before the new magnets are commercially available. This development opens whole new vistas to the design engineer because the iron particles can be embedded in plastics, metal, rubber or glass. The magnets are easily machined, drilled, tapped, soldered, and molded precisely into any desired shape.

AIR FORCE ACADEMY left the ground October 26, when the first columns of structural steel for the permanent buildings were hoisted into the air at Colorado Springs, Colo.

Like a gigantic erector set, the huge beams and girders for a warehouse building settled into place, and erection of buildings was officially underway for the service school and national monument being constructed north of Colorado Springs. Most utilities have been completed.

The buildings are part of the services and supply area, the housekeeping unit for the Air Force Academy. They are scheduled to be completed in July, 1957.

EVERETT S. LEE, one of the nation's best known engineers and past president of the American Institute of Electrical Engineers, retired November 30 after more than 40 years with the General Electric Co. Since 1951, Mr. Lee has been editor of the *General Electric Review*, which, under his tutelage, raised its circulation from 10,000 to more than 100,000 to become the country's largest-circulation engineering magazine. For more than 20 years Mr. Lee was executive engineer of the company's General Engineering Laboratory.

Helpful Data from

DE LAVAL

How to calculate the efficiency of worm gearing

The efficiency of worm gearing is determined by frictional losses at the tooth contact, bearings and oil seals plus losses from oil churning and windage. A formula for efficiency at the tooth contact may be developed from a consideration of the forces at the contact. Figure 1 shows these forces acting on a developed section of the worm thread. For simplicity the pressure angle has been assumed to be zero.

The coefficient of friction of the worm and gear is a function of the materials, finish, lubrication and rubbing speed. The latter is the relative speed between a point on the pitch surface of the gear and one on the pitch surface of the worm. The coefficient of friction varies very little at high rubbing speeds but rises with increasing rapidity as the speed drops below 500 fpm.

The efficiency formula developed in Figure 1 involves worm lead angle and the friction angle. Figure 2 provides a relationship between friction angle and rubbing speed based on tests made on accurately manufactured gearing consisting of hardened and ground worm and bronze gear operating in oil.

The formula for rubbing speed is:

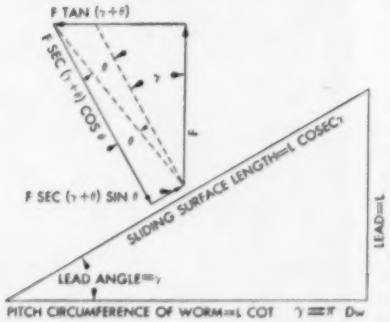
$$V = \frac{.262\ Dw \times \eta}{\cos\gamma}$$

where

V = Rubbing speed – feet per minute
Dw = Worm pitch diameter – inches
η = Worm speed – rpm
γ = Worm lead angle

FIGURE 1.

Development of equation for efficiency at contact between worm and gear



F = TANGENTIAL FORCE ACTING ON GEAR

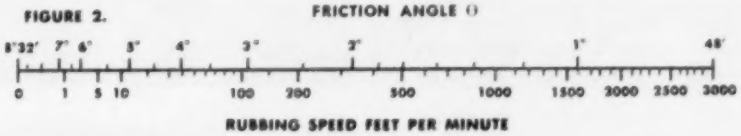
F TAN ($\gamma + \theta$) = TANGENTIAL FORCE APPLIED TO WORM

F SEC ($\gamma + \theta$) COS θ = FORCE NORMAL TO CONTACT SURFACE

F SEC ($\gamma + \theta$) SIN θ = FRICTIONAL FORCE

$$\text{EFFICIENCY} = \frac{\text{WORK REALIZED}}{\text{WORK APPLIED}} = \frac{L \times F}{L \cot\gamma \times F \tan(\gamma+\theta)} = \frac{\tan\gamma}{\tan(\gamma+\theta)}$$

FIGURE 2.



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WHAT THEY TELL US

▶**IN THE DECEMBER** 1956 issue, Reader G. N. of California described his problem of getting saturated steam in his laundry for his presses and spotting table. His boiler operates at 110 psi, but a reducing valve reduces steam to 80 psi for his dry-cleaning. However, the operator claims that steam at this pressure is too dry for efficient work on the presses and spotting table.

Now G. N. suggested using a cooling coil or condenser inside the steam header to reduce the steam temperature, and we suggested a desuperheater downstream from the reducing valve. Here are two comments from readers who have obviously had first-hand experience with the problem.

First, D. I. Calleja of the City Electric System at Key West, Florida, advises:

> First of all, steam pressure is really too high. Most likely G. N. set this higher because the boiler would not supply enough steam at 80 psi. Maybe G. N.'s business has increased, and he has been adding more machinery, causing the boiler to become too small. I have seen this happen quite often.
>
> First thing to do is to check the condition of the boiler for scale, tubes for soot, have right size tips on burner and water conditioner. See that traps are not stuck and releasing too much steam, and that the return water tank is vented properly. All of these cut down on boiler efficiency.
>
> Many operators set the head pressure on the pressing machine and use this one pressure on all types of garments. This is very unwise. Pressure should be set according to the material being pressed. If you are going to press material that has a tendency to shine, such as gabardine, it is advisable to loosen the head pressure and use the buck steam. This steam is more saturated than the head steam; sometimes it is a good idea to use a cloth cover for the head.
>
> For the spotting, as a rule you can get saturated steam just by throttling the valve that supplies steam to the gun. On some of the other types you have to throttle the valve that supplies steam to the header, and this decreases the steam pressure and the surrounding air will saturate the steam in the header.
>
> If G. N. belongs to any of the laundry associations, they can tell him whether his boiler has enough horsepower for his equipment.

Next is a very practical suggestion from Reader R. E. Driscoll of Texas, for using a desuperheating device on the main header. The desuperheater is controlled directly from the press.

> Under similar circumstances, the saturated steam problem was solved as shown on the attached sketch. A 1-in. ejector was injected in the steam line. Condensate make-up was then connected to the suction of the ejector. Solenoid valve was used, controlled by a mercury switch connected to the presser pedal. Amount of condensate educted was controlled by a small globe valve in the suction line.
>
> Whenever the presser pedal was operated, steam flowed, condensate was picked up and injected into the steam and thus saturated steam was produced.

▶**READER E. A. M.**, a professional industrial painter, said in the December issue that he had been called on to paint a large steel stack buff color, to match adjacent structures. The stack operates at 350 F. The paint job must be guaranteed for 3 years.

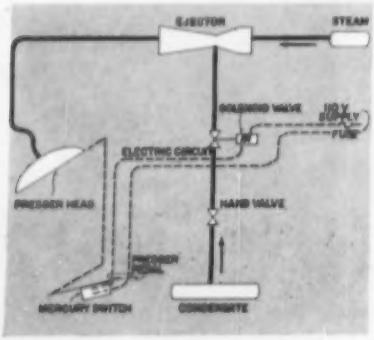
He was afraid he was courting paint failure because of the color, he said, although he would not have been concerned if he could use black or aluminum.

From Daniel M. Roop, administrative engineer at Baptist Memorial Hospital, Memphis, Tenn., came this comment:

> I read with interest your reader's inquiry regarding a buff colored stack paint as specified for high heat applications, in the December issue of POWER ENGINEERING.
>
> The writer has personally been faced with this same problem and solved it by using a paint manufactured by the Burk-Hall Manufacturing Co, called Silicon Stack Paint Buff, at a contractor's price of $12 per gal.
>
> This material has been in place for 14 months, and has weathered well and shown no signs of deterioration during this period. I would suggest, however, that all horizontal steel plate joints be caulked to prevent any staining from internal stack moisture. See photograph.
>
> Our stack serves a 1500-lb-per-hr destructor with temperatures up to 1300 F, and three 300-hp water-tube boilers.

Then we got word from E. A. M. that he is obtaining additional data on this problem, showing different solutions. These will be presented later.

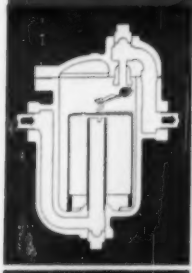
This is the sort of coöperation that makes us glad to be editors.



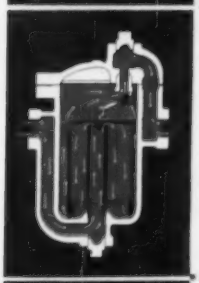
At left, diagram of Driscoll's plan for using ejector controlled from presser pedal to produce saturated steam whenever presser pedal is operated

At right, upper portion of steel stack, painted buff color to match buff brickwork, serving boiler plant at Baptist Memorial Hospital, as described by Daniel M. Roop. Building is new 400-bed wing. Shadow of adjacent building causes darkening on lower part of picture

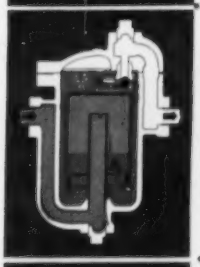
How Armstrong Trap Design Improves Plant Efficiency . . .



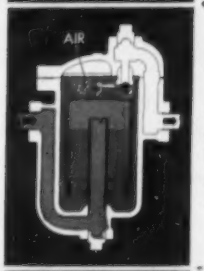
1 When trap is first installed, the inverted bucket is down and the valve is wide open. The large clearance between valve and seat minimizes restriction to condensate flow, contributing to large capacity.



2 When steam is turned on, note how condensate (solid color) flows down between bucket and trap body, then up and out through orifice. Dirt is held in suspension and washed out when valve opens.

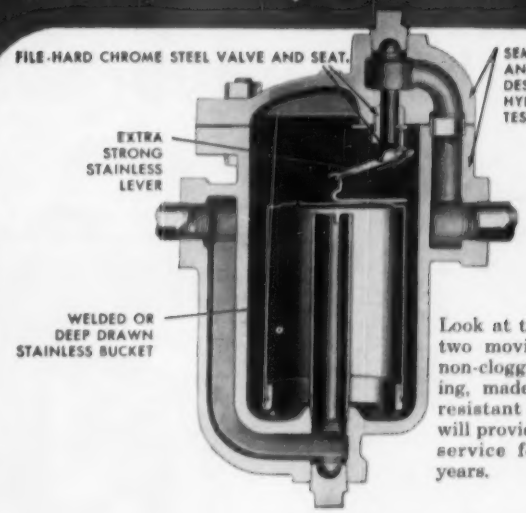


3 When steam reaching trap displaces less than ⅔ of the water in the bucket, it floats, closing the valve. Generous safety margin (dimension A) insures that steam will never reach trap orifice.



4 When more condensate enters trap, the bucket loses buoyancy and pulls on valve lever. (Note how incoming air passes through bucket vent and collects at top of trap, awaiting discharge.)

5 When weight of bucket times leverage overcomes pressure on valve, trap opens, creating momentary pressure drop that "pumps" condensate and non-condensibles from unit being drained.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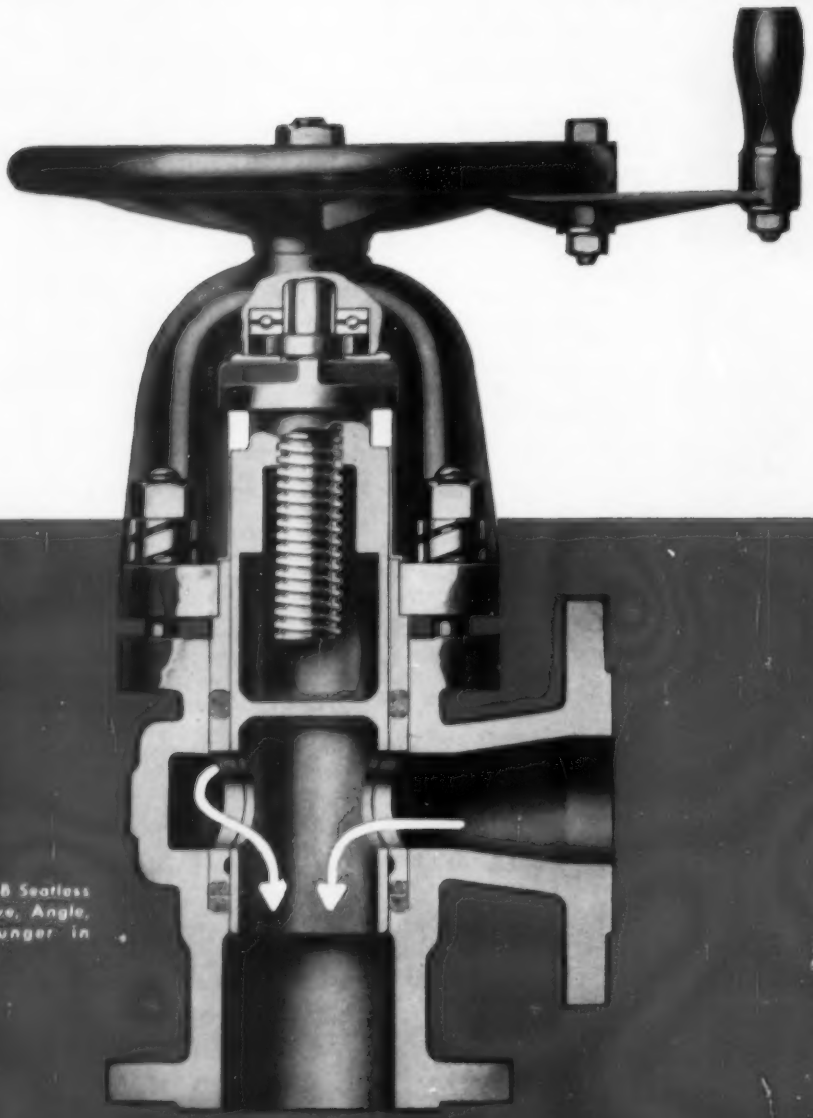
seatless

. . . for



Yarway Type B Seatless Blow-Off Valve, Angle, showing plunger in open position.

YARWAY

trouble-free blow-down service

YARWAY SEATLESS BLOW-OFF VALVES

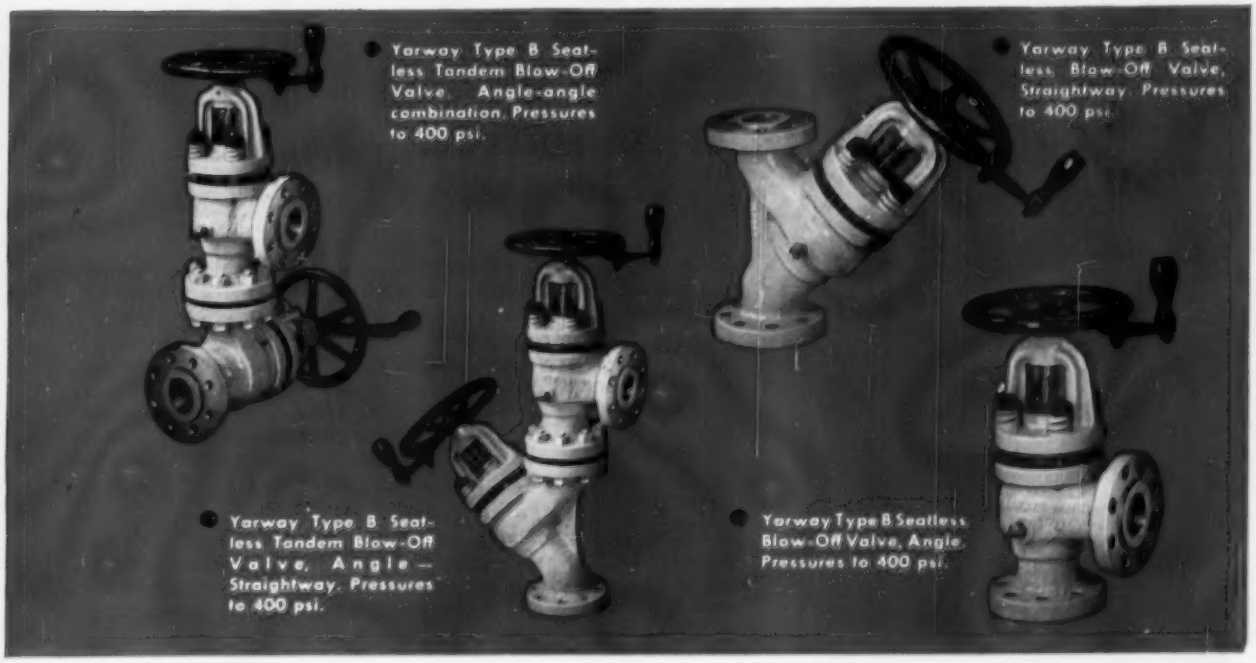
"Trouble preventers" is what YARWAY Seatless Blow-Off Valves are often called because they eliminate one of the commonest sources of trouble in low and medium pressure boiler blow-down service. *There is NO SEAT to score, wear, clog or leak.*

YARWAY Seatless Blow-Off Valves feature a balanced, sliding, hollow plunger design that permits free and easy operation—full, unobstructed flow.

More than 16,000 boiler plants today use YARWAY *Blow-Off Valves.*

YARWAY Bulletin B-426 shows all the latest types and features of YARWAY Seatless Blow-Off Valves. If you operate your boilers up to 400 psi, you'll find a copy helpful. For higher pressures, ask for Bulletin B-434. Write today.

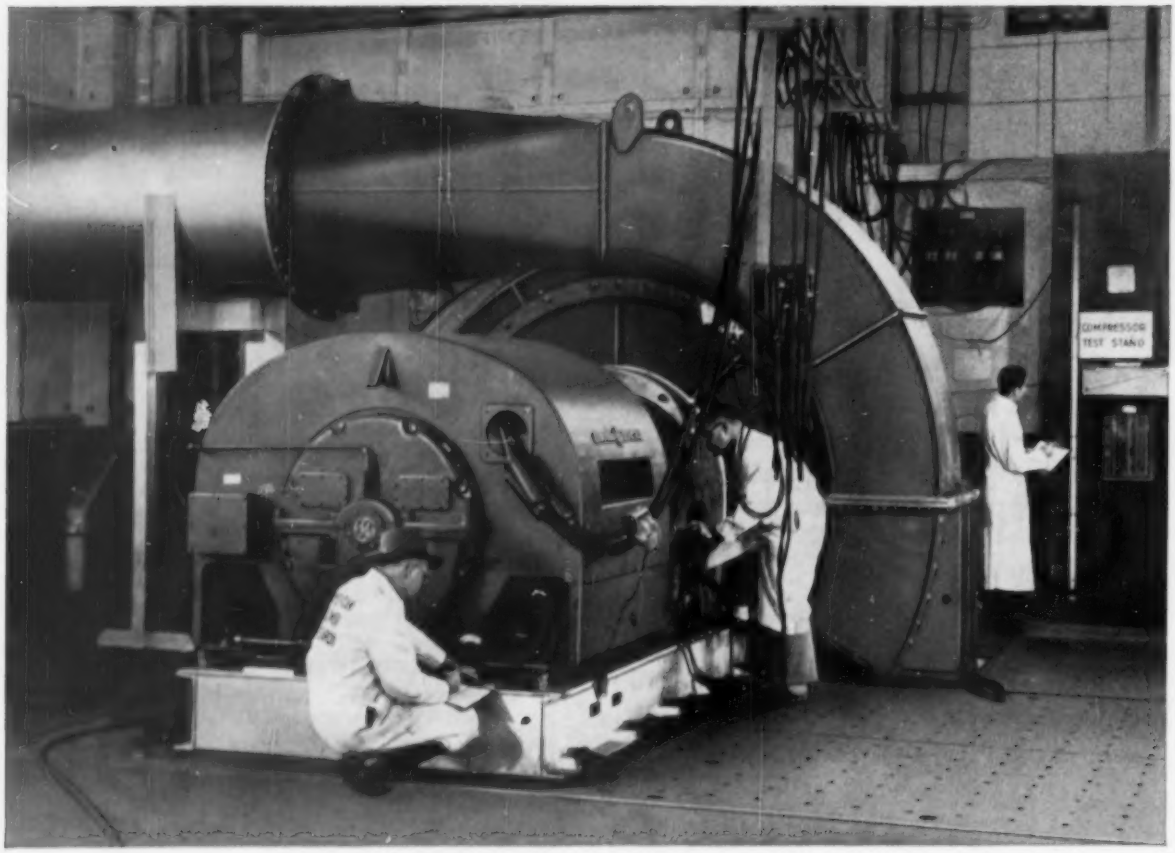
YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES


Yarway Type B Seatless Tandem Blow-Off Valve. Angle-angle combination. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Straightway. Pressures to 400 psi.
Yarway Type B Seatless Tandem Blow-Off Valve, Angle—Straightway. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Angle. Pressures to 400 psi.

— blow-off valves

For more data circle 506 on Post Card

Here's the latest air-handling



LABORATORY TESTED CENTRIFUGAL COMPRESSOR DELIVERS 330,805 POUNDS OF AIR PER HOUR!

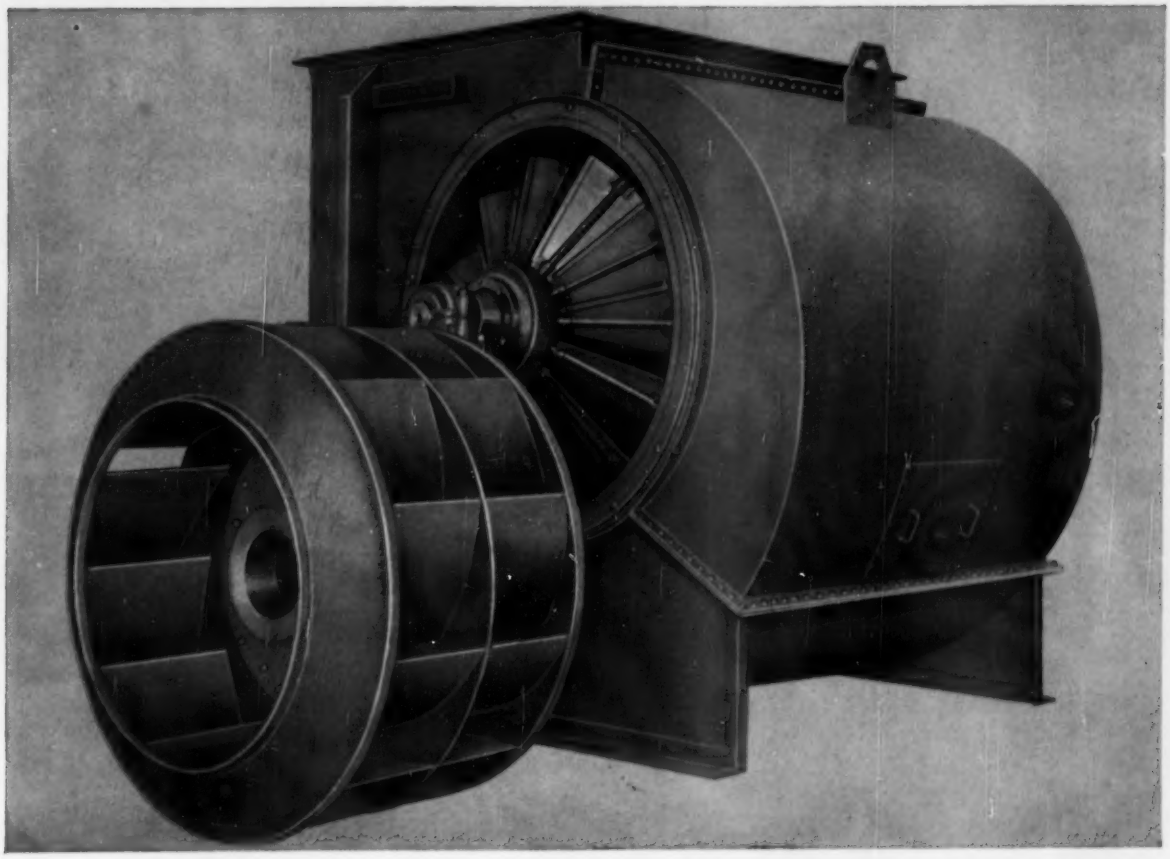
Cutaway of typical American Blower single-stage centrifugal compressor.

With the trend toward higher pressure requirements, American Blower has designed and built centrifugal compressors to furnish air for cyclone fired boilers. These compressors incorporate the use of a horizontally split, welded steel volute casing, variable inlet guide vanes, welded steel impeller of the shrouded type with impeller shaft supported by two journal bearings plus a Kingsbury thrust bearing arranged for positive forced-feed lubrication. This highly efficient compressor is driven by a 1000 HP, 1800 rpm, induction motor, delivers 330,805 pounds of air per hour at a static discharge pressure of 67.5 inches water gauge.

Like every American Blower single-stage centrifugal compressor – 30 to 2250 HP – this compressor has been completely tested in accordance with the A.S.M.E. Power Test Code. Such testing guarantees the mechanical operation and performance of all American Blower compressors.

Outstanding features: (1) Improved scroll-shaped casing design. (2) Unobstructed long diffuser passage converts velocity energy into pressure, contributes to quiet operation. (3) Annulus packing minimizes recirculation of gas around impeller inlet. (4) Removable inlet nozzle for accurate alignment of annulus packing. (5) Aero-dynamic design of impeller blades for high efficiency, long life. (6) Welded-steel baseplate "stress relieved" prior to machining.

equipment from American Blower

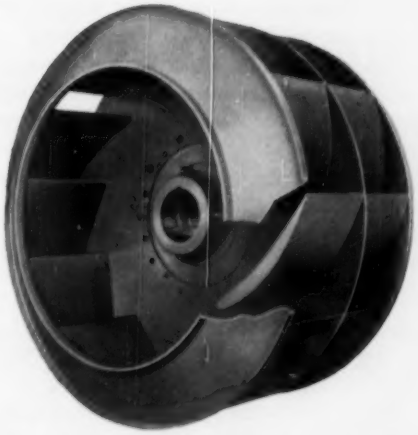


AIRFOIL FAN HAS ADVANCED DESIGN FOR HIGH EFFICIENCY, LOW OPERATING COST

Featuring a functionally designed airfoil blade, American Blower's improved Airfoil Fan is the industry's best in the non-overloading-horsepower type of centrifugal fan.

That's because smooth interworking of improved streamline inlets, wheel rims, and housing minimizes turbulence, resulting in higher efficiency, lower power consumption. The non-overloading-horsepower characteristic makes it possible to select a driving motor close to the fan horsepower.

Why not talk to an American Blower sales engineer about *your* requirements. His knowledge of air-handling applications can prove invaluable to you. Call our nearest branch office, or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products.



Special design of the airfoil blade and matching streamline inlet are the top features of American Blower Airfoil Fan. The dieformed, reinforced, and welded blades are extra strong, extremely efficient. Single- and double-inlet Airfoil Fans are available in many sizes, and for volumes up to 1,000,000 cfm.

AMERICAN BLOWER

Division of AMERICAN-Standard

For more data circle 507 on Post Card

VU Boilers exceed performance guarantees

at Central Fibre Products Co.

Plant designed by H. M. Wilson Company, Inc., Philadelphia, Pa., Engineers.

The two C-E Vertical Unit Boilers installed in this plant have exceeded their guaranteed efficiency of 82.6% and guaranteed peak capacity of 100,000 lb steam per hr. These stoker-fired units are equipped with a C-E overfire air system that *works to perfection* by completely burning out all combustibles at the proper point, allowing for a *very clean furnace.* There is *absolutely no smoke* from the stacks. Furthermore, the draft loss of each unit – as well as the flue gas temperature leaving the economizer – is lower than the customer expected.

The above comments are all contained in a report written by the H. M. Wilson Company, Inc., Consulting Engineers to the Central Fibre Products Company, of Quincy, Illinois. Of course, it won't hurt to get the opinion of the customer, too, if you're interested. They will be very happy to discuss their boiler installation with you.

Incidentally, when you need boilers, please consider the fact that Combustion has a complete line of steam generating and fuel burning equipment suitable for any pressure, temperature and fuel requirement.

COMBUSTION ENGINEERING

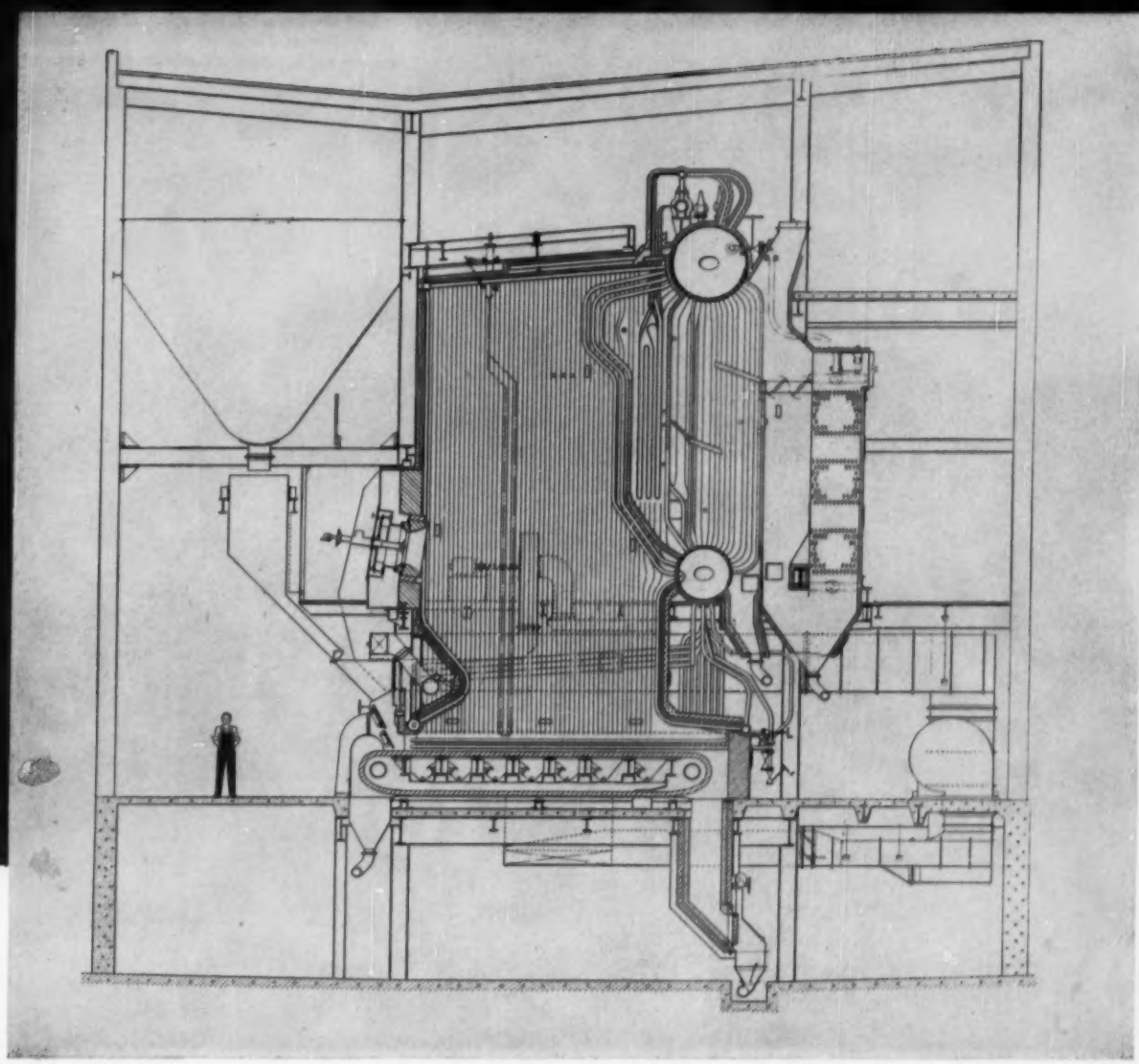
C-E

B-967

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

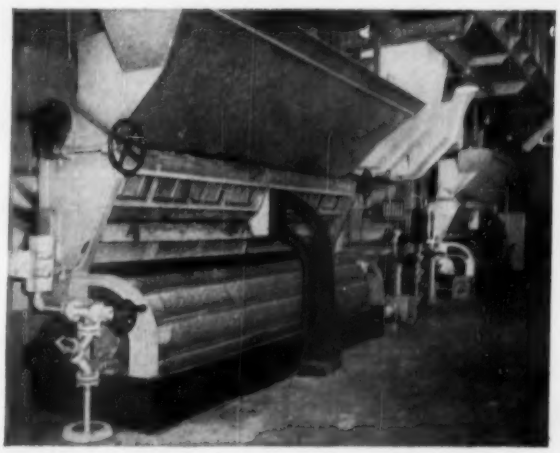
Canada: Combustion Engineering-Superheater Ltd.

steam generating units; nuclear reactors; paper mill equipment; pulverizers; flash drying systems; pressure vessels; home heating and cooling units; domestic water heaters; soil pipe.



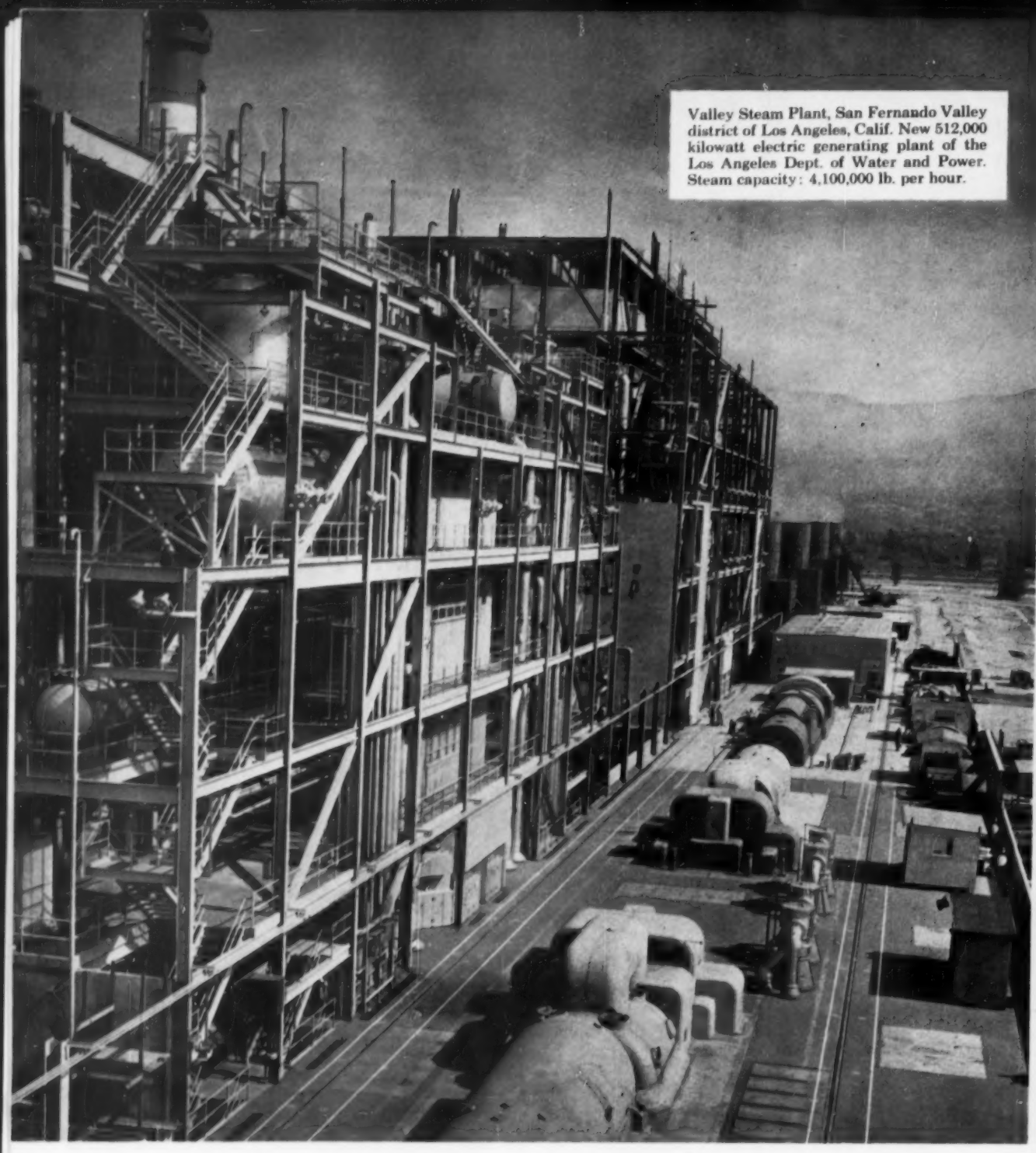
Cross-sectional elevation of the C-E Vertical Unit Boiler, Type VU-50X, installed in the Mill Division Plant of the Central Fibre Products Company, Quincy, Illinois. There are two units, each fired with a C-E Traveling Grate Stoker and designed for the future use of oil or gas as alternate fuels.

Present operating conditions are 185 psi and 450 F. Each unit has a maximum continuous capacity of 85,000 lb per hr and a four hour peak of 100,000 lb per hr. The boilers are designed for 650 psig and in the future will operate at 610 psig and 650 F.



Firing aisle at the Central Fibre Products Mill Division plant at Quincy, Ill. This is a front end view of two C-E Traveling Grate Stokers which fire the VU Boilers as shown by the cross-sectional elevation drawing.

For more data circle 508 on Post Card



Valley Steam Plant, San Fernando Valley district of Los Angeles, Calif. New 512,000 kilowatt electric generating plant of the Los Angeles Dept. of Water and Power. Steam capacity: 4,100,000 lb. per hour.

How big Valley Steam Plant demineralizes

• Valley Steam's feedwater requirements are typical for today's modern, high-capacity stations. Its raw water supply, delivered from the Los Angeles Owens River Aqueduct, contains 132 ppm total solids but is high in dissolved silica (18 ppm). The 1500 psig and 1850 psig boilers require a large amount of high quality feedwater.

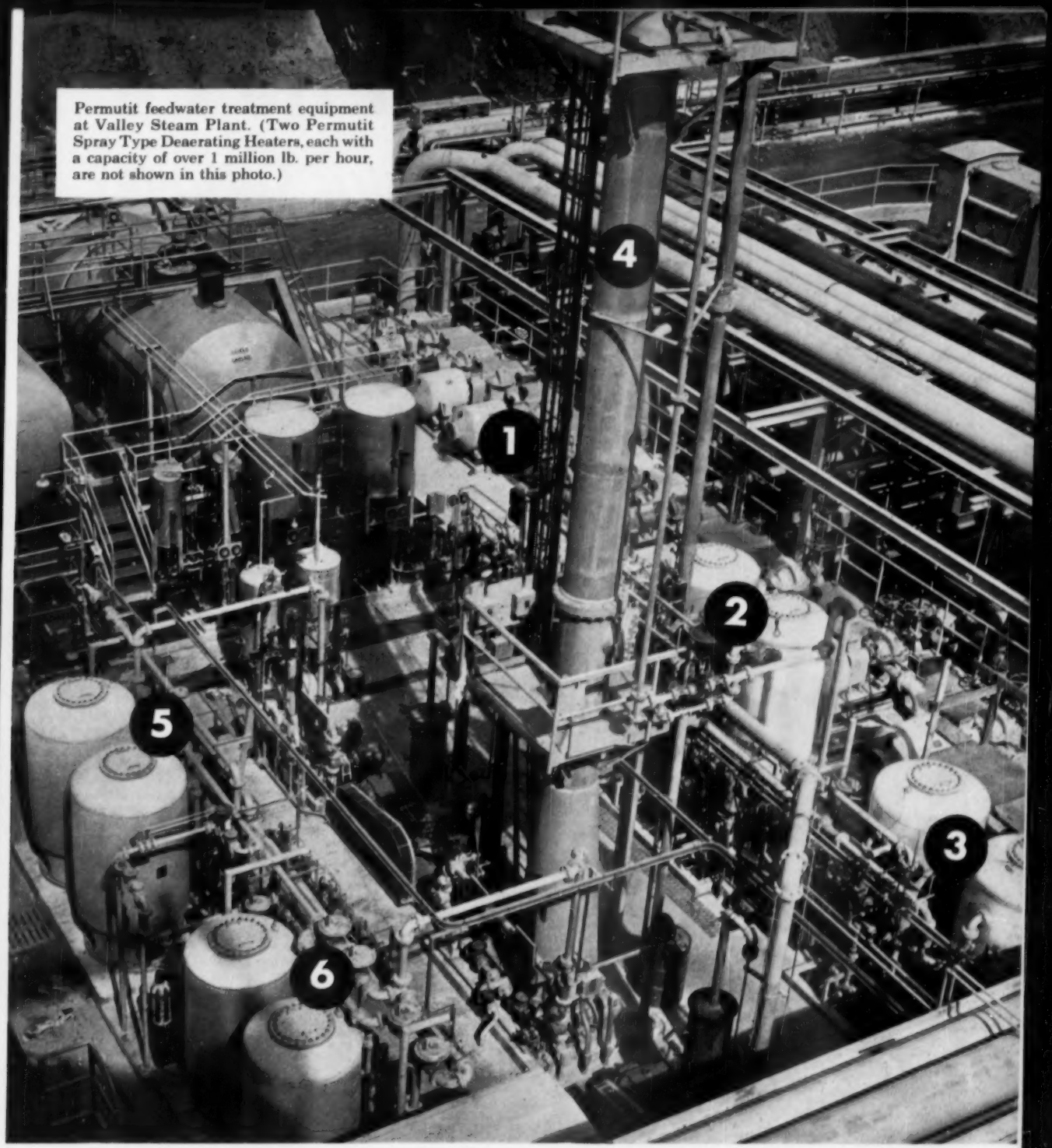
The 4-step PERMUTIT Demineralizer was custom-designed for this problem . . . not only in size, arrangement and number of ion exchange units, but also in the selection of the ion exchange resins.

That's why Permutit's broad experience with many different demineralizing systems and its manufacture of ion exchange resins as well as equipment are of particular value in solving large-plant water problems.

The Permutit Company, Dept. PE-2, 330 West 42nd Street, New York 36, N. Y. Permutit Company of Canada, Ltd., 207 Queens Quay, Toronto 1, Ontario.

PERMUTIT EQUIPMENT FOR POWER PLANTS:

Demineralizers · Zeolite and Hot-Process Softeners · Dealkalizers · Deaerating Heaters · Pressure and Gravity Filters · Chemical Feeders · Aerators · Blowoff equipment · CO_2 Indicating Recorders · Zeolites and Resins · Instrument Panels · Control Cubicles



Permutit feedwater treatment equipment at Valley Steam Plant. (Two Permutit Spray Type Deaerating Heaters, each with a capacity of over 1 million lb. per hour, are not shown in this photo.)

its feedwater with **PERMUTIT**® equipment

1 **Diatomite filters** (behind column) remove dirt and other suspended matter . . . keep ion-exchanger beds clean for top efficiency.

2 **Primary hydrogen cation units** contain Permutit Zeo-Karb® . . . remove metallic cations such as calcium, magnesium, sodium.

3 **Weakly basic anion units** contain Permutit A exchange resin . . . remove chlorides, sulfates, nitrates.

4 **Vacuum deaerator** removes CO_2 at low cost. Reduces the load on the second stage anion exchangers.

5 **Secondary hydrogen cation units** (Zeo-Karb) "polish" water by removing "slippage" from first cation units.

6 **Strongly basic anion units** contain Permutit S-2 resin . . . remove dissolved silica . . . also catch "slippage" from first anion units.

Quality of effluent: Zero free CO_2, under 1 ppm total solids, under 0.2 ppm silica.

For highest efficiency and lowest operating cost, the regeneration of the demineralizing equipment is completely automatic and operated by Permutit instrument panels and control cubicles.

For more data circle 509 on Post Card

The 4-step PERMUTIT Demineralizer was custom-designed for this

The Permutit Company, Dept. PE-2, 330 West 42nd Street, New

CO_2 Indicating Recorders · Zeolites and Resins · Instrument Panels · Control Cubicles

THE MODERNIZATION OF

gives *Western Electric Company* more power per worker at 40% less cost and an annual savings of $500,000

Before Modernization — Sixteen traveling grate fired units that were replaced by three Riley Units.

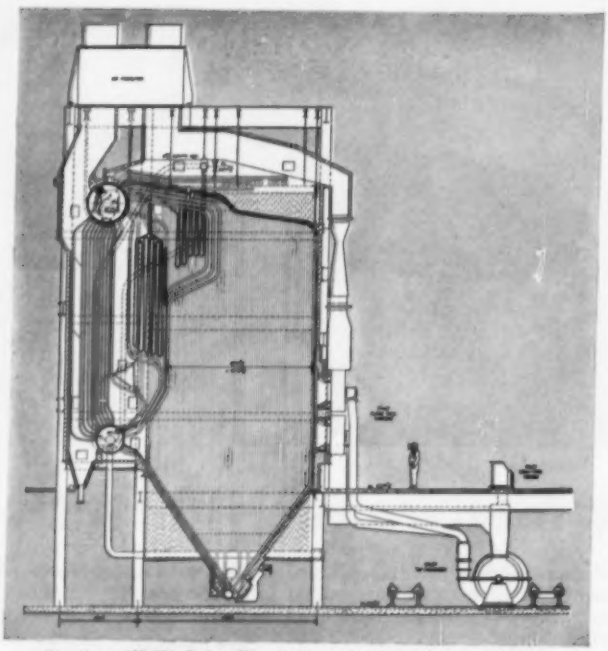
After Modernization — Firing Aisle of new Riley installations that feature Riley Flare Type Burners.

Six Riley "50" Pulverizers assure sustained high fineness of the Illinois and Indiana coals used at Hawthorne. Riley Pulverizers are noted for their quiet vibrationless operation and their ability to operate efficiently with the wettest coals.

When faced with a continually increasing annual expense for energy production in relation to number of workers, officials at Western Electric Company's Hawthorne Works at Chicago, Illinois decided that investment in modernization was needed. Their final selection of equipment was based on facts developed in exhaustive studies of heat cycle and labor costs.

The three Riley 150,000 lbs/hr. Units that were installed, replacing sixteen small boilers, are equipped to burn coal, oil or gas to supply steam for all manufacturing and plant services independent of outside sources. The services are distributed as steam, electric power, compressed air and hot water for space heating.

UNITED ENGINEERS & CONSTRUCTORS, INC.
CONSULTING ENGINEERS



The three 150,000 lb/hr. Riley Units at Hawthorne feature patented Single Header Hopper Bottoms. Furnace is designed for coals with ash fusion temperatures as low as 1900 F. Steam Pressure 1000 psig., temperature 835 F.

For more data circle 509 on Post Card

HAWTHORNE POWER PLANT

Power MODERNIZATION PROGRAM

Since completion of modernization, operating results thoroughly justify Western Electric Company's findings and the amount of its investment:

HIGHER EFFICIENCY

Three 150,000 lbs/hr. Riley Boilers that replaced sixteen old units operate at efficiencies of 85% as against 67%.

LOWER FUEL COST

Cost of fuel has been reduced 40%; coal used has been Southern Illinois or Indiana carbon and screenings with no difficulties experienced with ash removal and furnace slagging; furnaces stay clean even when ash fusion temperatures are as low as 2000° F.

HIGH AVAILABILITY

Each unit rated at 200,000 lbs/hr. peak capacity has operated successfully as high as 240,000 lbs/hr. in tests and has been available 98% of the time.

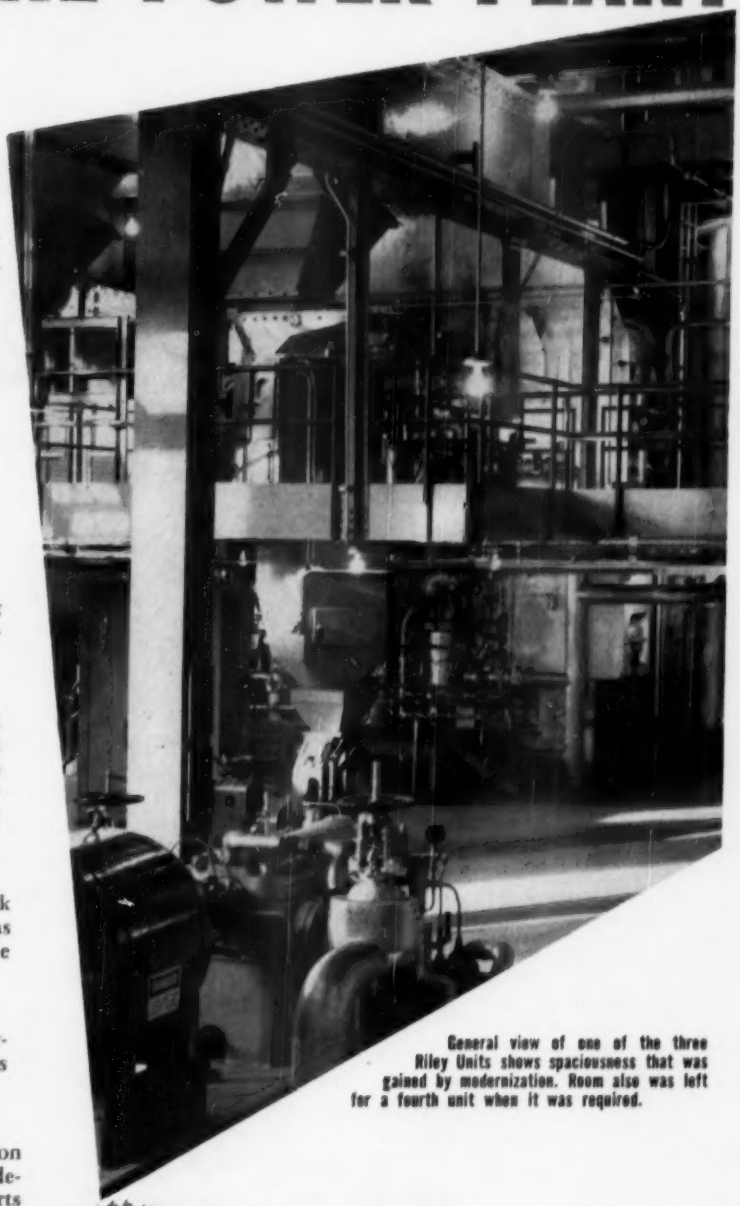
LOWER OPERATING COSTS

A 50% reduction in plant operating personnel was affected with maintenance savings amounting to $100,000 annually.

INCREASED SAVINGS

Basis for modernization was a production level equivalent to 23,000 kw maximum demand and 45% load factor. Recent reports show demand at 26,000 kw with 48% load factor, resulting in a total annual savings after fixed charges of over $500,000.

THESE FACTS PROVE that it pays to modernize . . . and with Riley Steam Generating and Fuel Burning Equipment. Furthermore . . . of the seventeen recipients of POWER'S Modernization Awards of 1954 and 1955, seven featured Riley Units complete with Riley Fuel Burning Equipment. They are: Western Electric Co., Iowa-Illinois Gas and Electric Co., Bendix Aviation Corp., Carbide and Carbon Chemicals Co., Garlock Packing Co., The Flintkote Co. and Pennsylvania R. R. Company. In the 1956 contest both Allis-Chalmers and Thomas A. Edison Co. joined the ranks.



General view of one of the three Riley Units shows spaciousness that was gained by modernization. Room also was left for a fourth unit when it was required.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY

Stoker Corporation

WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 510 on Post Card

"Heating in our switch was causing '*lights-out*' shutdowns until we changed to cooler operating Fusetron Fuses"

Thomas Lavin, Building Engineer
Railway Exchange Building
Denver, Colorado

Mr. Lavin Continues:

"We had considerable trouble with heat developing in a lighting switch and causing fuse blows. It was very annoying having the lights go out so often—and having regular maintenance work interrupted to replace fuses.

"Checking with an ammeter we found the continued load to be 28 ampere. This indicated that 30 ampere fuses in use were the right size for safe protection. Nevertheless, the renewable fuses we had installed kept blowing.

"Evidently, what we needed were the same size fuses that would operate cooler to eliminate heating in the switch.

"At the suggestion of a salesman we tried 30 ampere Fusetron dual-element fuses. Our heating problem immediately disappeared. This was 7 or 8 months ago and we have had no trouble with the switch overheating—and our—'lights-out' shutdowns are a thing of the past."

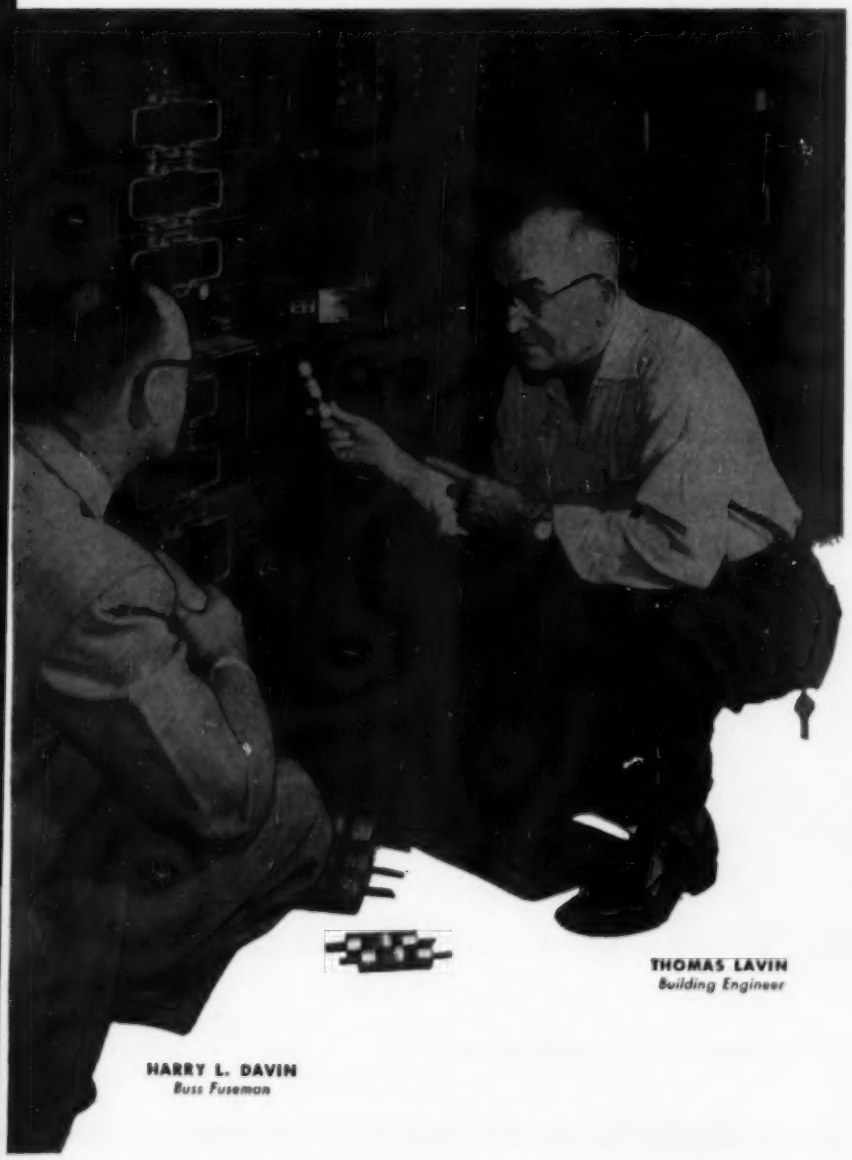
Here's why Fusetron Fuses protect against needless blows caused by excessive heating of panels and switches

Fuses, like other protective devices operate from heat created by the current flowing through them. Thus they produce some heat even in normal operation.

Sometimes the heat is not dissipated from switches and panels fast enough. This piled up heat over-heats fuses and reduces their carrying capacity. Then fuses often blow even though not loaded to their rated capacity.

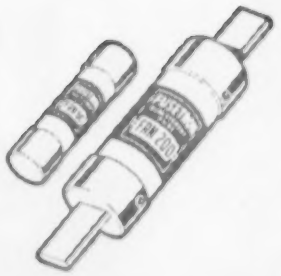
A logical answer to this heating problem is the use of Fusetron fuses. Fusetron fuses produce less heat because they have less electrical resistance than ordinary fuses. For example, ordinary fuses have 55 to 117% greater resistance than Fusetron fuses in 250 volt sizes and up to 140% greater resistance for 600 volt sizes.

Since the lower resistance of Fusetron dual-element fuses means less generation of heat, switches and panels operate much cooler. This materially reduces or wipes out entirely useless shutdowns caused by fuses blowing due to overheating of panels and switches.



HARRY L. DAVIN
Buss Fuseman

THOMAS LAVIN
Building Engineer



Save time, trouble and money by using Fusetron dual-element Fuses.

THEY PROVIDE 10 POINT PROTECTION

1 High interrupting capacity—protect against heaviest short circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes. **2** Protect against needless blows caused by excessive heating—lesser resistance results in cooler operation. **3** Protect against needless blows caused by harmless overloads. **4** Provide thermal protection—for panels and switches against damage from heating due to poor contact. **5** Protect against waste of space and money—permit use of proper size switches and panels. **6** Protect motors against burnout from overloads. **7** Give DOUBLE burnout protection to large motors—without extra cost. **8** Protect motors against burnout due to single phasing. **9** Make protection of small motors simple and inexpensive. **10** Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5000 AMPS. — USE BUSS Hi-Cap FUSES!

They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

Play Safe! *install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

BUSSMANN MFG. CO.
(Div. of McGraw Electric Co.)
University at Jefferson,
St. Louis 7, Mo.

FUSETRON
BUSS

167

For more data circle 511 on Post Card

BURLINGTON, VT. ELECTRIC LIGHT 100,000 LBS. PER HOUR WICKES IN THE NEW POWER PLANT

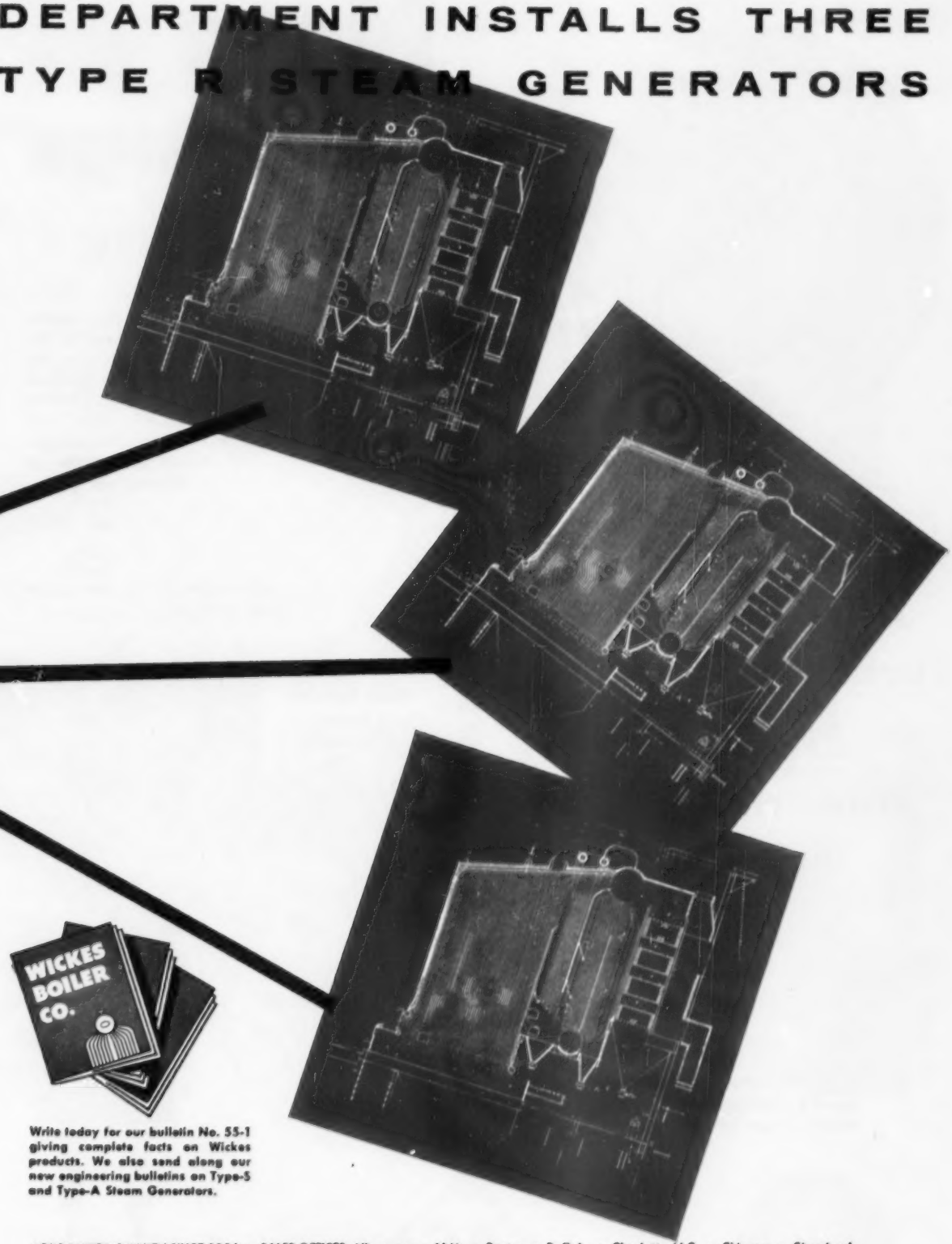
At the modern plant of the Burlington, Vermont Electric Department, three Wickes type R steam generators provide a powerful and unfailing steam supply. Each unit delivers 100,000 pounds of steam per hour, contains 7480 square feet of boiler heating surface, and 2320 square feet of water wall heating surface. Each steam generator is equipped with a superheater, airheater and economizer. These boilers have a design pressure of 1000 psi. This modern plant is operated by the Green Mountain Power Corporation. Superintendent of Burlington's Electric Light Department is W. A. Stebbins.

THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION

SAGINAW, MICHIGAN

DEPARTMENT INSTALLS THREE TYPE R STEAM GENERATORS



Write today for our bulletin No. 55-1 giving complete facts on Wickes products. We also send along our new engineering bulletins on Type-S and Type-A Steam Generators.

RECOGNIZED QUALITY SINCE 1854 **• *SALES OFFICES:* Albuquerque, N.M. • Boston • Buffalo • Charlotte, N.C. • Chicago • Cleveland Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D.C.**

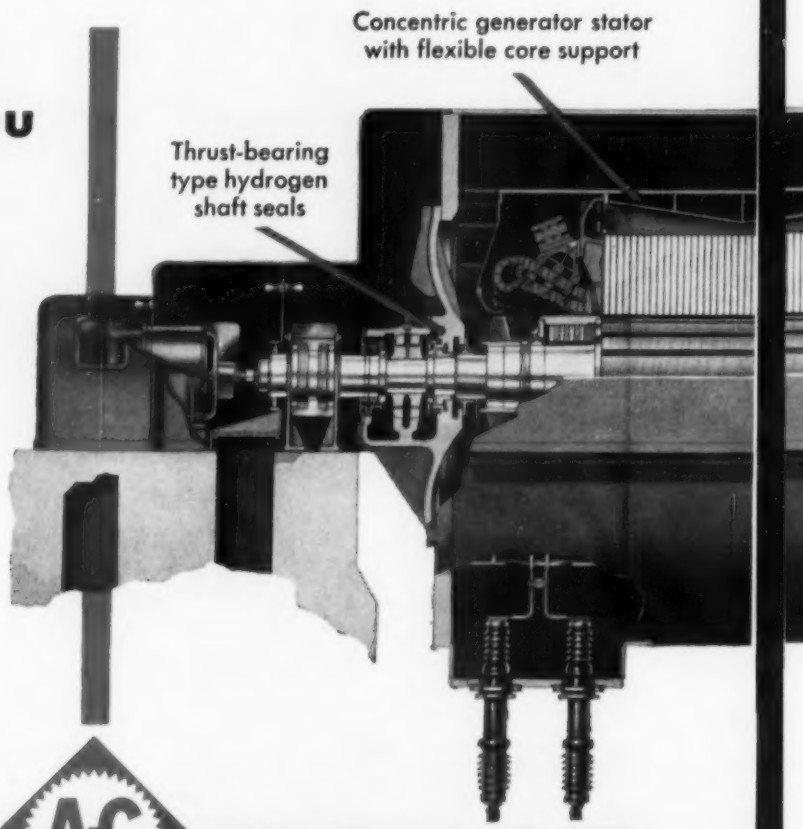
164

For more data circle 512 on Post Card

Now in Ratings

Here is the turbine rotor for one of the 16,500-kw units now being built. For this 850-psig, 900-F AIEE-ASME turbine, rotor shaft and wheels are of integrally forged construction.

Allis-Chalmers Turbines Give You MORE Modern Design Features



CUTAWAY VIEW of 16,500-kw unit shows the development of impulse turbine design for larger ratings.

A-C ALLIS CHALMERS

ALLIS-

Production up to 16,500 Kw

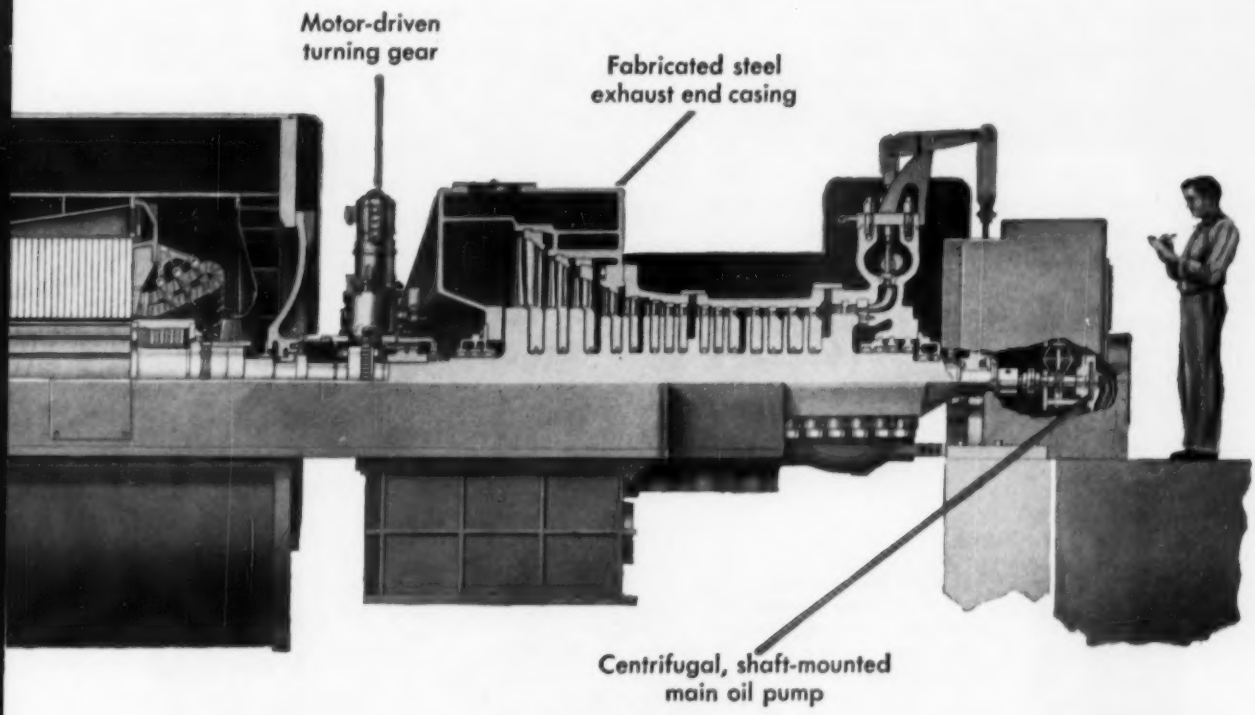
NEW Large WA-Series Turbines Offer

- **Advanced Design Features**
- **Simplified Installation**
- **AIEE-ASME and NEMA Ratings**

NEW WA-Series steam turbine-generator units now being manufactured include the 10,000-kw NEMA standard rating as well as 12,650-kw and 16,500-kw AIEE-ASME preferred standard condensing ratings. The 16,500-kw units have hydrogen-cooled generators.

Incorporated in the design are time-proved labyrinth steam sealing, removable external glands, high chrome alloy steel buckets and nozzles, reliable governing system, and unit shipment and installation — plus additional large turbine and generator features.

To get MORE information on economical, dependable units 2000 kw and larger, call the nearest A-C district office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.



CHALMERS

LIVE BETTER ELECTRICALLY

A-5127

For more data circle 513 on Post Card

Planetary Roll and

complements the Foster Wheeler line of pulverized fuel systems

THE FOSTER WHEELER Type MB planetary roll and table pulverizer, developed in Germany, is a constant-speed mill which has proved to be exceptionally efficient and economical to operate and maintain.

In the MB pulverizer, grinding action takes place between a slowly rotating horizontal table and three spheroidal rollers, uniformly spaced around the axis of the table and subjected to controlled thrust pressure by a large number of coil springs. The motion of the table causes the rollers to rotate while circling planet-fashion and rolling over the material on the grinding ring.

Air or gas, entering from below the pulverizer table, floats the ground particles up into the classifier, located in the top of the housing. Particles too coarse to float fall back onto the table for further pulverization. All routine adjustments to the spring tension gear or classifier vanes can be made externally while the mill is in operation.

Wide experience abroad indicates that this new addition to the complete line of heavy-duty FW pulverizers offers the following advantages.

1. ***Low Power Consumption***
   Assures exceptional economy of operation, year after year.

2. ***Low Maintenance***
   Extremely rugged construction and accessibility of wearing parts reduces down-time for servicing.

3. ***Uniform Product Fineness***
   Pulverizer and classifier design assures extreme uniformity of particle size.

4. ***Pressurized or Suction Operation***
   Provides complete flexibility for various types of service.

5. ***All Necessary Adjustments Made Externally with Mill Operating***
   Avoids shut-downs for changes in pulverizer pressure or classifier adjustment.

6. ***Simple Renewal and Replacement of Grinding Rolls and Table***
   Cuts down-time for infrequent replacement of wearing parts.

THE TYPE MB PULVERIZER, with Foster Wheeler feeders, distributors, burners and fans or exhausters, provides an exceptionally efficient and economical pulverized fuel system.

For complete information on the new PLANETARY ROLL & TABLE PULVERIZER, write for Bulletin MB-55-5.

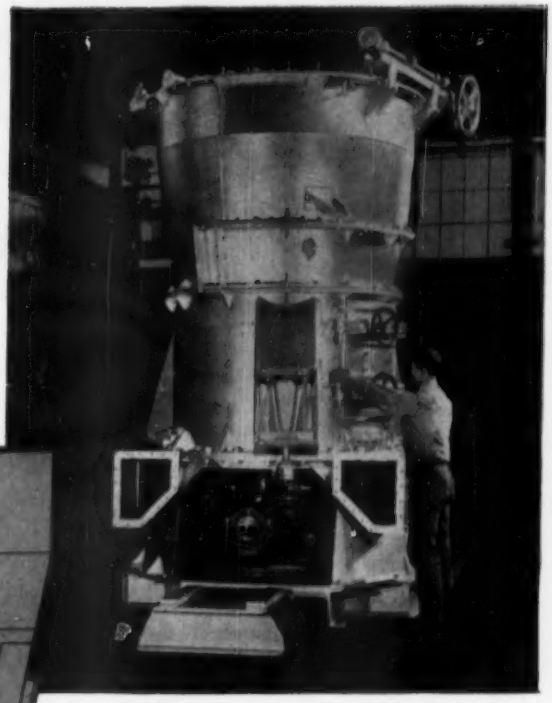
For full details on Foster Wheeler heavy-duty BALL MILL pulverized fuel systems, write for Bulletin BP-53-3.

Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.

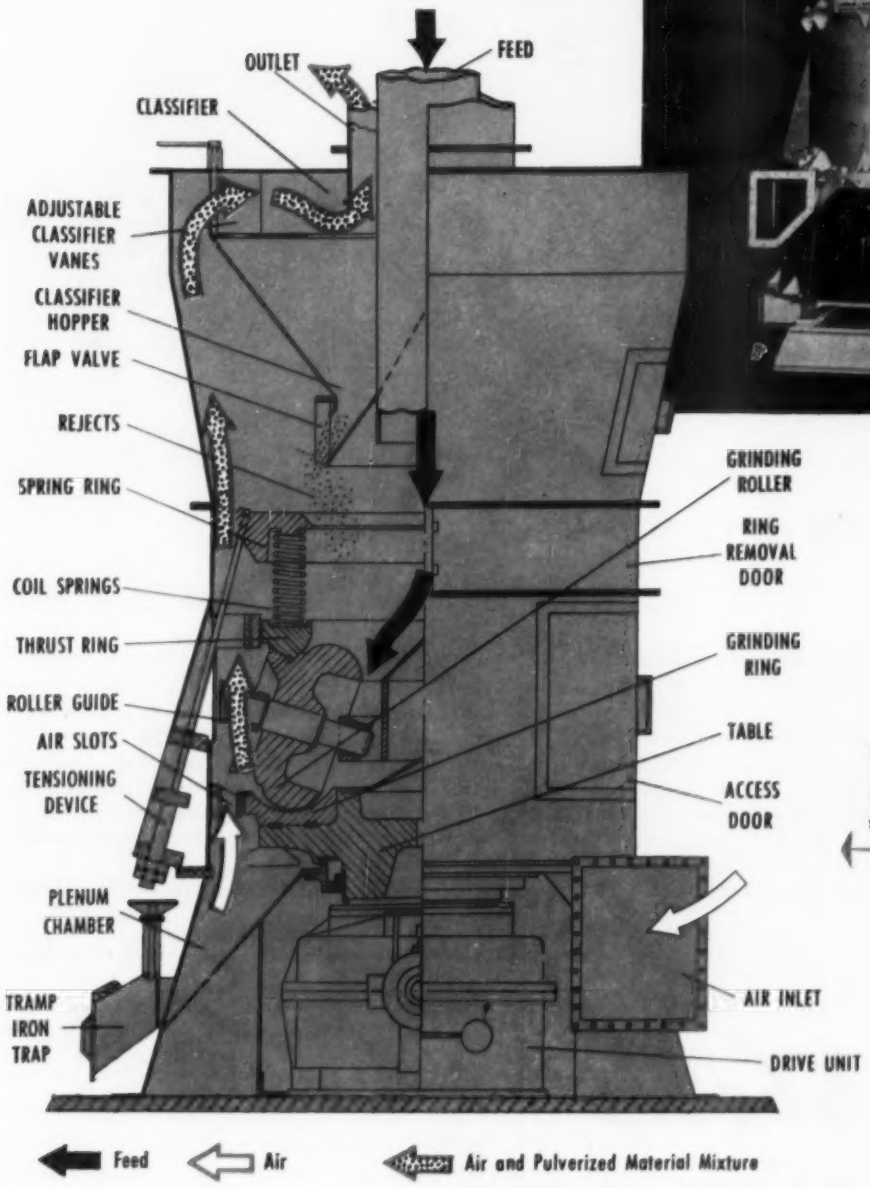
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

Table Pulverizer



Exterior view of completely assembled Foster Wheeler Type MB planetary roll and table pulverizer.



Sectional drawing of Type MB pulverizer with parts identified to show construction and operation.

For more data circle 514 on Post Card

Unretouched photo shows what happens when a boiler feed line is clogged with calcium carbonate deposits. CAUSE: *lack of chemical stability in feed water.* REMEDY: *properly balanced water treatment.*

LINE OF MOST RESISTANCE

A heavy build-up of scale, like that shown in the illustration, will gradually reduce the effective diameter of feed line piping, and will result in seriously restricted carrying capacity.

The line must be shut down for maintenance or replacement, causing expensive down time in the plant. Proper water conditioning will prevent this unnecessary loss. This is but one of the many problems presented by the corrosive elements of water.

In Dearborn's complete line of water conditioning products, there are treatments to eliminate scaling, sludge, carry-over, return line corrosion and other similar difficulties. Dearborn combines the proper treatment with the right control methods under technical supervision. The result: less down time and greater operating efficiency.

Dearborn Supervisory Service provides you with the three elements necessary to maintain the best in a water conditioning program—positive control, top performance effectiveness and maximum economy.

Mail the coupon for complete information.

Dearborn®

...a leader in water conditioning and corrosion control for 70 years

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PG, Chicago 54, Ill.

Gentlemen: ☐ Send my copy of Dearborn Water Conditioning Program.
☐ Have a Dearborn Water Treatment Engineer call.

Name.....*Title*.....

Company.....

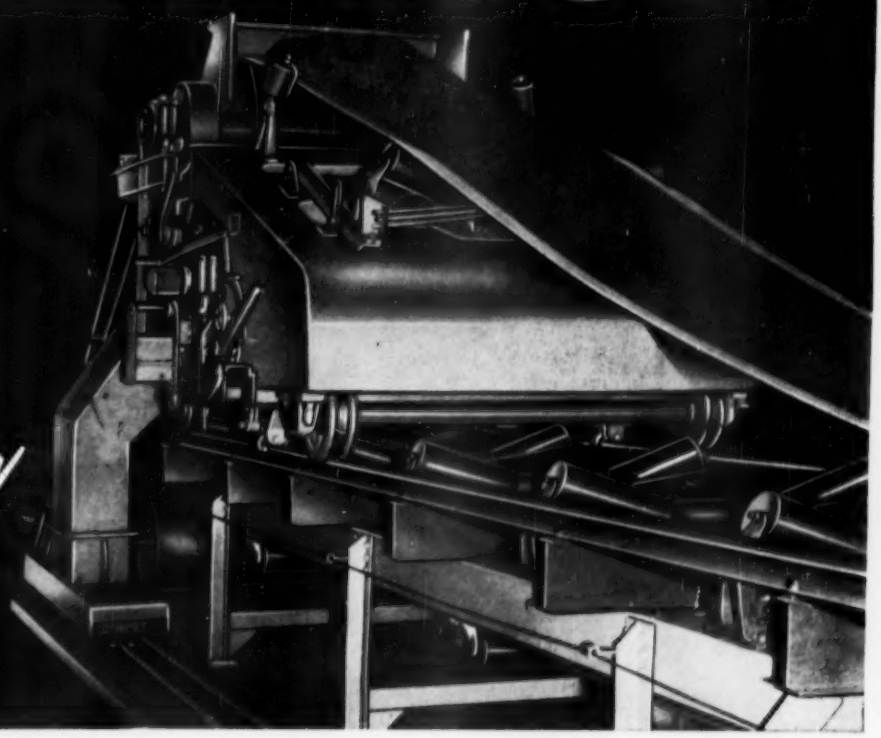
Address.....

City.....*Zone*.....*State*.....

For more data circle 515 on Post Card

STEPHENS ADAMSON

coal conveying systems for *TODAY* and *TOMORROW*



S-A tripper and exclusive zipper bunker seal. Seal zips open and closed. Eliminates dusting.

The power plant built for present needs is expected to serve the next generation too. The men responsible for the purchase of vital coal conveyor systems for power generation may expect to buy only one such system in their lifetime.

Such a system must function flawlessly for years to come. It must be economical in installation and delivery costs and must be sparing of man power.

To create such a power servant demands the finest engineering, the best construction, and above all, experience. These are S-A qualities and they have been earned in long service to the power field. This is why, more and more in coal handling systems, the big name is S-A—the name with a 50 year reputation for building equipment that will serve the power needs of our generation—and the next.

Knittel crushers built by S-A and used to reduce run-of-mine coal to stoker size. They are compactly constructed, requiring little headroom and are extremely dependable. S-A crushers are available in many sizes and variations to meet specific requirements.

S-A REDLER conveyors and elevators, patented products, ideally move crushed coal over any plane, completely enclosed, eliminating all dusting problems. Specially designed flights move coal forward in a solid column. Discharge is possible at single or multiple stations.

S-A manufactures a wide range of material handling products in three complete plants in U. S. and Canada.

Belt Conveyors
Belt, Pan & Plate Feeders
Ship Loading Boom Conveyors
Stacking Conveyors
Storage & Reclaiming Systems
"Natural Frequency" Vibrating Conveyors
REDLER Conveyor-Elevators
ZIPPER Conveyor-Elevators
Conveyor Belt Cleaners
Headshaft Holdbacks
Grizzlies & Screens
Centrifugal Pliers
Bin Gates & Tunnel Gates
Car Pullers & Spotters
Bucket Elevators
Skip Hoists
SEALMASTER Ball Bearing Units

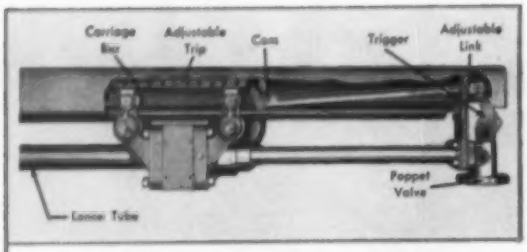
• *Write for a bulletin on any of the above products.*

STEPHENS-ADAMSON MFG. CO.

86 RIDGEWAY AVENUE, AURORA, ILLINOIS
LOS ANGELES, CALIFORNIA
BELLEVILLE, ONTARIO

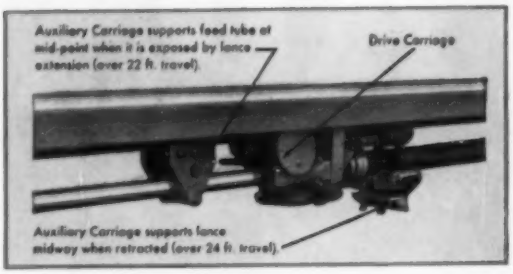
For more data circle 534 on Post Card

Introducing DIAMOND SERIES 300 IK



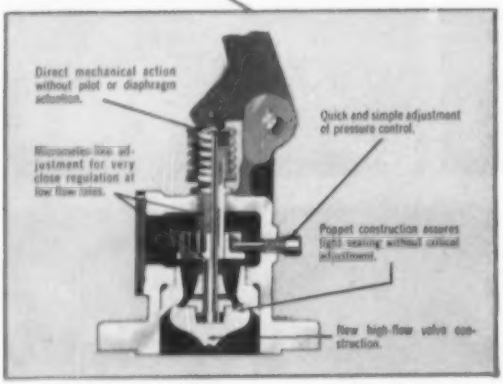
MECHANICALLY OPERATED VALVE

Control of blowing medium is automatic, positive and accurate by means of a simple, dependable mechanically operated valve. As lance begins movement into boiler, trip on carriage opens valve through a linkage. At end of retraction, trip closes valve. All pilot or diaphragm valve elements are eliminated. Trip is adjustable.


Auxiliary Carriage supports feed tube at mid-point when it is exposed by lance extension (over 22 ft. travel).
Drive Carriage
Auxiliary Carriage supports lance midway when retracted (over 24 ft. travel).

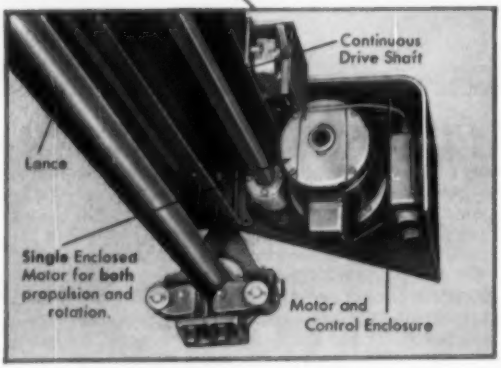
AUXILIARY CARRIAGES (FOR EXTRA LONG TRAVEL)

On extra long blowers, one auxiliary carriage supports lance midway when retracted, preventing undue bending. Second auxiliary carriage is dropped at mid-point to support feed tube when it is exposed by lance extension.


Direct mechanical action without pilot or diaphragm actuation.
Micrometer-like adjustment for very close regulation at low flow rates.
Quick and simple adjustment of pressure control.
Poppet construction assures tight seating without critical adjustment.
New high-flow valve construction.

POPPET VALVE WITH ADJUSTABLE PRESSURE CONTROL

Diamond dependable poppet valve with improved streamlined flow contours and adjustable pressure control that permits easy, accurate setting of pressure at individual valve and independent of other blowers. Poppet construction assures tight seating without critical adjustment. Stem, seat and disc are stainless steel. Stellited seating surfaces are available.



STATIONARY GEAR MOTOR

Lance propulsion and rotation are by a *single* enclosed gear motor which drives a continuous shaft running the full length of blower and providing power to carriage. This construction makes it possible to mount motor in a fixed position at the front end for better protection and accessibility.

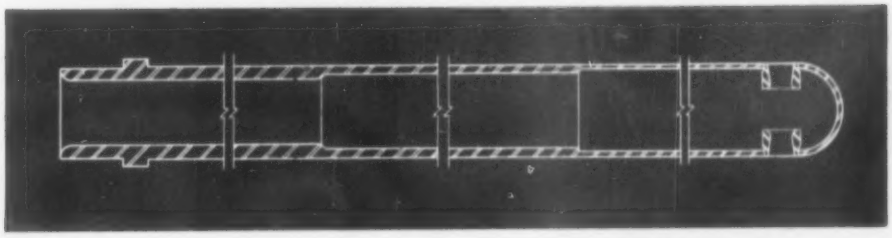
7594

Diamond **DIAMOND POWER**

LONG RETRACTING BLOWER

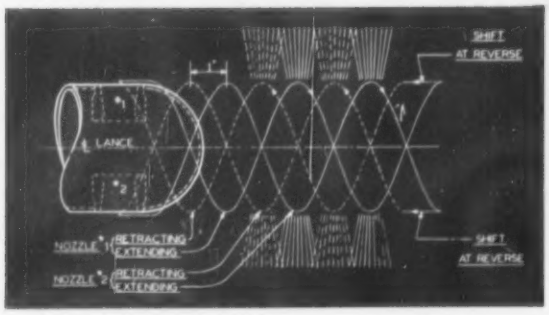
The Diamond Series 300 IK Blower sets a new and higher standard of efficiency, economy and dependability in the cleaning of heating surfaces that require a long retracting lance type blower. Pointed out in detail are some of its important features. Others are a *single* outboard support point to simplify installation and the attractive "backbone" cover for greater rigidity and protection of the entire blower assembly from dirt, damage, the elements and personnel hazards.

This new Series 300 IK is the culmination of more than 20 years' experience building and applying long travel blowers. It well illustrates the Diamond design philosophy: *"Keep it simple . . . keep it basic . . . avoid unnecessary complications."* It is further evidence of the fact that YOU CLEAN BOILERS BETTER AND AT LOWER COST WITH DIAMOND BLOWERS.



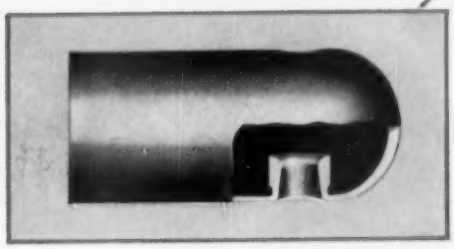
STEP-TAPER LANCE
(FOR EXTRA LONG TRAVEL)

Extra long lance has minimum droop due to step-taper construction which employs up to four different wall thicknesses. Lightest wall is at nozzle end to reduce bending moment. Lance is chrome alloy for heat resistance.



IMPROVE CLEANING PATTERN

Close and positively controlled helical cleaning pattern assures maximum cleaning effectiveness. Blowing pattern diagram illustrates how return travel path is exactly intermediate with forward travel path so that there is a *positive nozzle sweep every inch.*



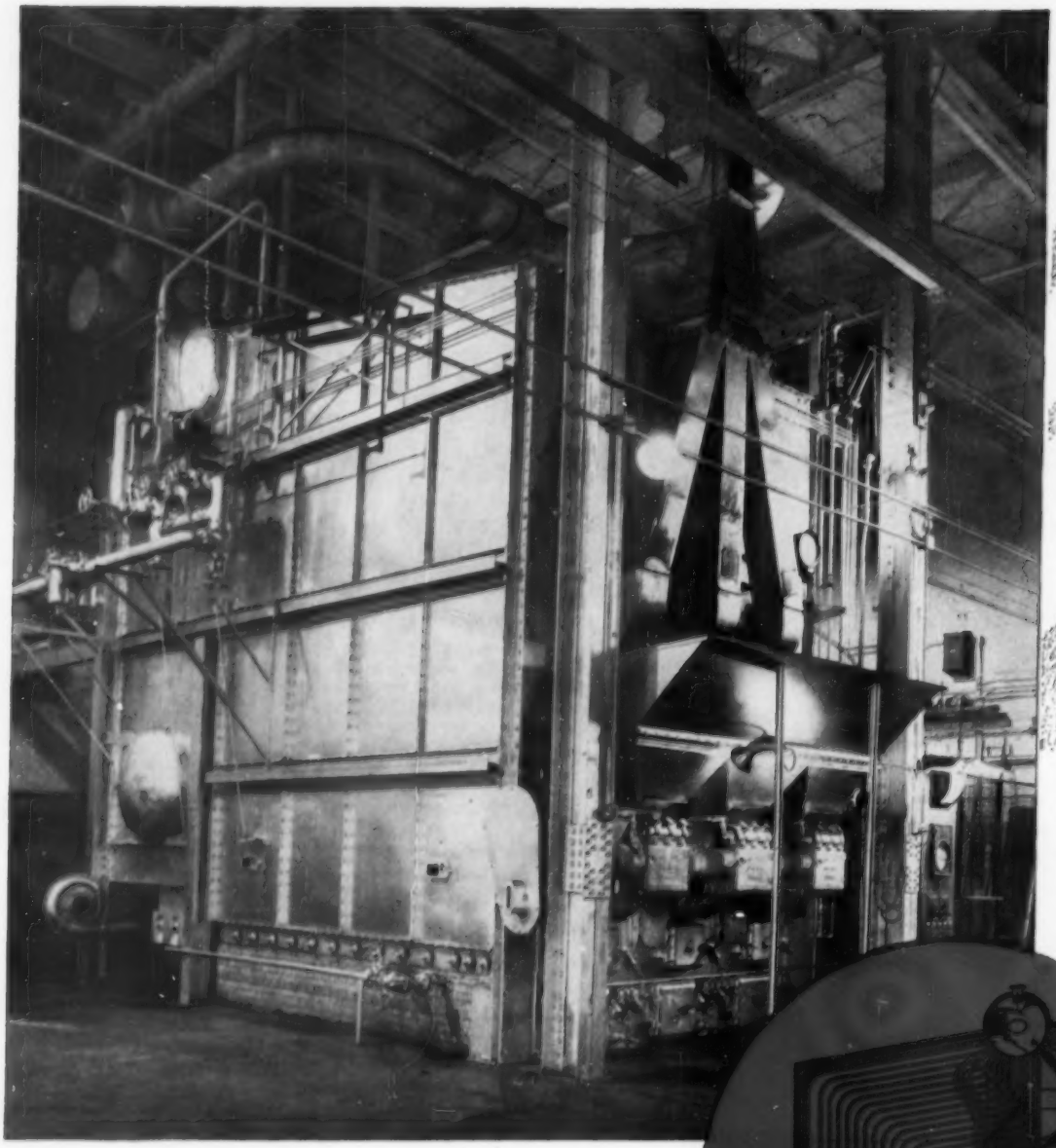
IMPROVED DIAMOND NOZZLE

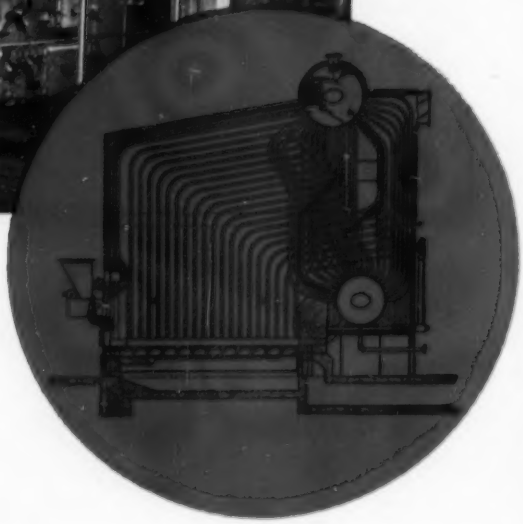
New design Diamond "Type A" Nozzle is the result of several years' research and the testing of more than 50 different contours. The modified venturi produces maximum impact pressure and cleaning effectiveness with minimum expenditure of cleaning medium. (Steam or compressed air.)

SPECIALTY CORP. **LANCASTER, OHIO**
DIAMOND SPECIALTY LIMITED—Windsor, Ontario

For more data circle 516 on Post Card

ERIE CITY~





Data

Boiler	Erie City 4 VC
Capacity	35,000 lbs./hr.
Operating Pressure	250 lbs.
Stoker	Erie City Dump Grate Spreader

~STEAM GENERATOR

at the BRUNSWICK-BALKE-COLLENDER COMPANY

Burns Coal + Wood Waste...

Another major industrial concern, Brunswick-Balke-Collender Company of Muskegon, Michigan, has turned to Erie City Iron Works to satisfy its steam needs. Brunswick required a 35,000 lbs./hr. boiler, fired with coal, and having a properly designed furnace to burn their constant accumulation of wood waste. To satisfy these requirements, Erie City engineers used a standard 4-VC Boiler and a triple feeder dump grate spreader stoker.

The furnace was specifically designed to burn the coal that was most economically available and with sufficient furnace volume to burn the wood waste. The boiler proper is designed with drainable baffles and reinjection system to return any unburned particles of wood or coal to the furnace. The VC unit was selected for its compact design and low installation cost. The complete water cooled furnace eliminates the necessity of heavy refractory walls and thereby reduces maintenance costs.

This installation at Brunswick-Balke-Collender is another fine example of how Erie City engineers can adapt standard products to suit particular requirements.

For additional information on Erie City VC boilers or spreader stokers, contact your local Erie City Agent or write for bulletins VC 3B and SB 423B.

ERIE CITY
117 Years in Steam Generation

You can depend on Erie City for sound engineering

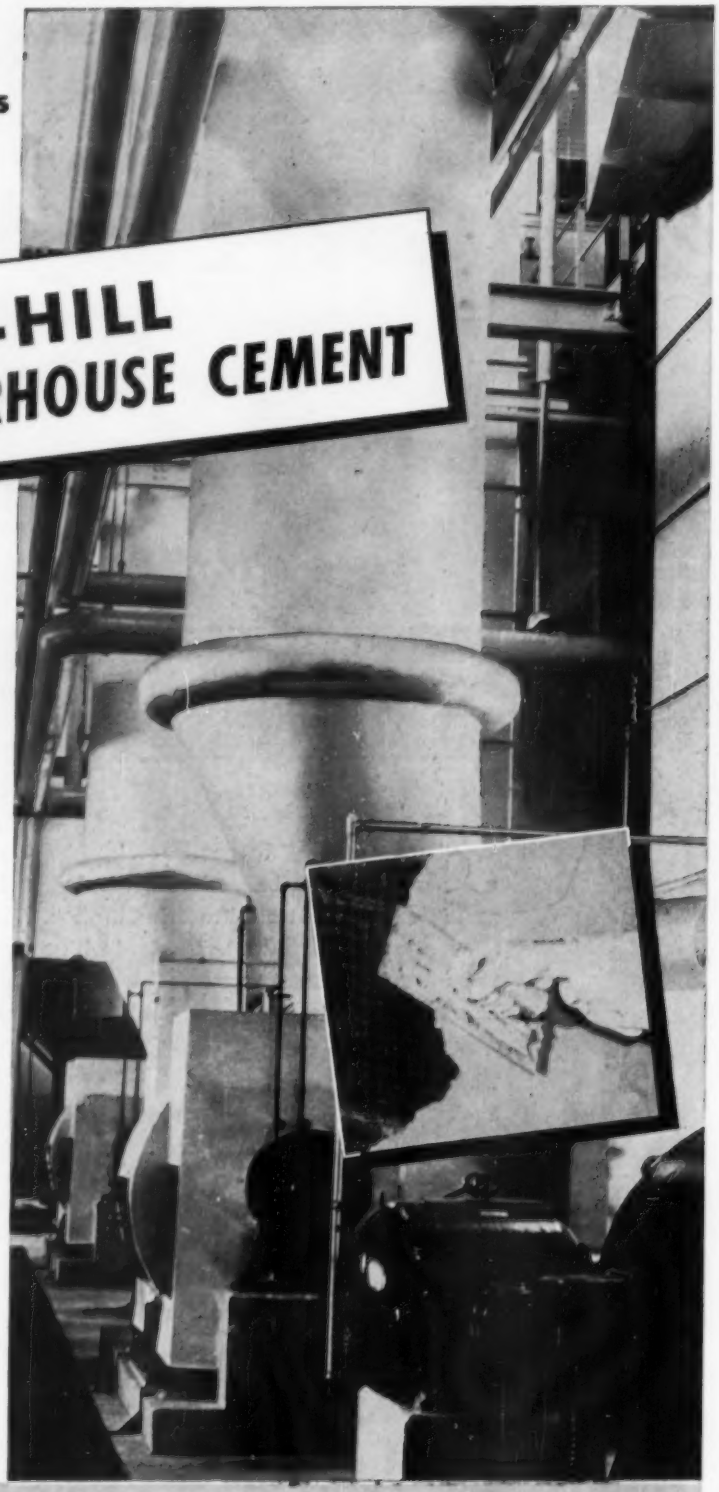
ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

For more data circle 517 on Post Card

at the
Ford Motor Company's
Power House
in Mahwah, N. J.

BALDWIN-HILL SUPER POWERHOUSE CEMENT



. . . it insulates as it finishes

- B-H Super Powerhouse Cement applied over B-H Mono-Block on Induced Draft Fan Housing and Stacks.
- Dries quickly to a smooth, glazed white surface that may be painted with water or oil-base paints. Aluminum paint used on this application.
- High temperature resisting mixture of spun mineral wool and hydraulic setting binder minimizes drying shrinkage and eliminates shrinkage cracks.
- Easily troweled; excellent adhesive qualities prevent fall-off during application.

S See our catalog in Sweet's Plant Engineering File or write for a copy.

BALDWIN-HILL COMPANY

202 Breunig Ave., Trenton 2, N.J.

Huntington, Ind. Kalamazoo, Mich.

Temple, Texas

COMPLETE LINE OF BALDWIN-HILL INSULATING PRODUCTS

B-H Mono-Block	B-H Super Powerhouse Cement	B-H No. 100 Pipe Insulation
B-H Blanket	B-H No. 1 Insulating Cement	B-H 85% Magnesia Pipe Insulation
B-H Koldboard	B-H No. 52 Asbestos Cement	B-H Calcium Silicate Pipe Insulation
B-H Bond-Tite	B-H Spun Felt Insulation	B-H Mono-Kover Pipe Insulation
B-H Weatherseal	B-H Fine-Fyber Felt Insulation	B-H Spun Mineral Wool Fill

For more data circle 518 on Post Card

FIVE STEPS TO 493,000 KILOWATTS

Units 1 and 2 of Potomac River Station are each of 92,000 kilowatts capability. Units 3, 4 and 5 are of 103,000 kilowatts capability each.

- The initial installation of Potomac Electric Power Company's Potomac River Steam Station serving the District of Columbia and surrounding territory was completed in 1949.
- A second unit was installed in 1950.
- The third unit was installed in 1954.
- Unit #4 went on the line in 1956.
- And a fifth unit is scheduled for completion in 1957.
- Total capability of the five units will be 493,000 kilowatts.

The design and construction of the entire station was by Stone & Webster Engineering Corporation.

•

If you have a problem of design or construction, our broad experience in these and related fields may help you solve it. Write or call us for complete information on our services.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston Los Angeles San Francisco Seattle Toronto

Bailey Recorder for receiving pneumatic and electric signals.

Pick any four, plug in, and record

Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

Measured Variables

- % combustibles
- combustion
- conductivity
- density
- differential
- draft
- flow
- liquid level
- % oxygen
- pH
- position
- pressure
- ratio
- smoke density
- specific gravity
- speed
- temperature
- vacuum

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY
1040 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METER
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

For more data circle 520 on Post Card

R. S. M.
Design features like these help Edward sell more steel non-return valves than any other manufacturer in the world.
B. J. B.

ROCKWELL BUILT
Edward Valves

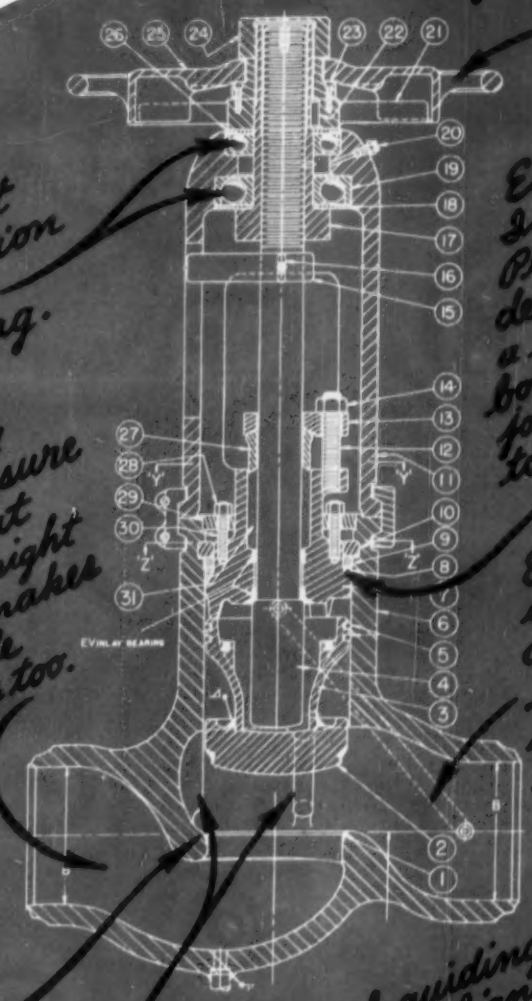
Edward Impactor handwheel seats big valve tightly - allows one man to do the job of three.

Patented Evalthrust bearing construction eases operation reduces stem drag.

Edward Improved Pressure Seal design makes a leak proof bonnet body joint, is easy to disassemble.

Streamlined body really helps. Pressure drop is only about half what you might guess. Edward streamlined angle non-return valves too.

Equalizer aids disk-piston lift, reduces motion and extends life of guiding surfaces.



Integral Stellite seat is best. Only Edward has it on large valves.

Full length rib guiding of disk provides perfect alignment, insures true seating and reduces danger of hang ups.

When it comes to steel non-return valves, let's order Edward and have them quote on other valves too.

PIECE NO.	NAME OF PIECE	REQ'D.	MATERIAL	SPECIFICATIONS	STANDARD NO.
1	SEAT	1	STELLITE		456
2	DISK	1	FORGED ALLOY STEEL STELLITED	ASTM A182 GRADE F11	456
3	PISTON-WELDED TO DISK	1	CAST STEEL	ASTM A216 GRADE WCB	113
4	GUIDE	1	CAST IRON	ASTM A48 GRADE 25	113
5	PISTON RINGS	2	CAST IRON	ASTM A48 GRADE 25	113
6	BODY	1	CAST STEEL-C-0.30% MAX CAST STEEL-C-0.30% MAX CAST STEEL-C-0.30% MAX	ASTM A216 GRADE WCB ASTM A216 GRADE WCB ASTM A216 GRADE WCB	113 113 113
7	BONNET	1	CAST STEEL	ASTM A487 GRADE CA15	487
8	PRESSURE SEAL GASKET	1	ARMCO IRON	ANNEALED & PLATED	456
9	GLAND	1	CAST IRON		
10	GLAND O-RING	1	RUBBER		
11	PACKING RETAINER	1	CAST IRON	ASTM A48 GRADE 25	113
12	PACKING	1	GRAPHITE		
13	STUD	2	CAST STEEL	ASTM A193 GRADE B7	193
14	NUT	2	CAST STEEL	ASTM A194 GRADE 2H	194
15	HANDWHEEL NUT	1	CAST STEEL	ASTM A216 GRADE WCB	113
16	HANDWHEEL	1	CAST STEEL	ASTM A216 GRADE WCB	113
17	YOKE BUSHING	1	CAST BRONZE		432
18	BEARING WASHER	1	STEEL-CHROMIZED	ASTM A322 GRADE 5	322
19	ANNULAR CONTACT BALL BEARING	1		SAE STANDARD	
20	PACKING FITTING	1	PISTON-HEAD INDUSTRIAL		
21	YOKE	1	CAST STEEL	ASTM A216 GRADE WCB	113
22	CAP-SEAL KEY	1	STEEL		
23	HANDWHEEL BUSHING	1	CAST BRONZE		432
24	HANDWHEEL WASHER	1	STEEL PLATE	ASTM A283 GRADE D	283
25	HANDWHEEL	1	CAST STEEL	ASTM A216 GRADE WCB	113
26	INDICATOR WASHER	1	STEEL PLATE	ASTM A283 GRADE D	283
27	STUD	2	STEEL	ASTM A193 GRADE B7	193
28	NUT	2	STEEL	ASTM A194 GRADE 2H	194
29	SCREW-RETAINER NUTS	2	STEEL	ASTM A193 GRADE B7	193
30	SCREW-RETAINER STUD	2	STEEL	ASTM A193 GRADE B7	193
31	PACKING RINGS		HIGH TEMPERATURE PACKING		

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

EDWARD GLOBE NON-RETURN VALVE
PRESSURE SEAL BONNET — WELDING ENDS
GENERAL ASSEMBLY

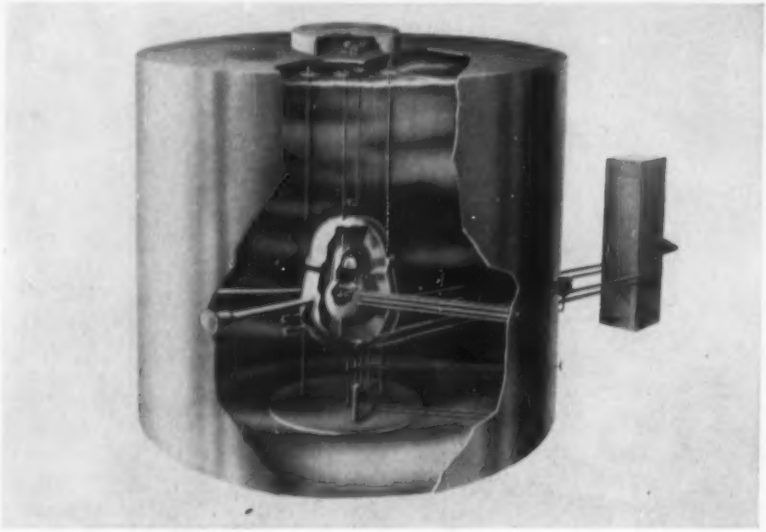
DRAWN [illegible] | CHK'D O. Ross | APP'D [illegible] | DATE [illegible]

DRAWING NO. AE-3213-6

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

One-man Laboratory Reactor designed for industry, hospitals and schools—available for $55,000*

A new atomic tool that will speed and broaden nuclear research and training has been designed and developed by ATOMICS INTERNATIONAL. Here is a low cost instrument that even a moderately-budgeted hospital, industrial or educational laboratory can use to teach and conduct research in nuclear science.



New Laboratory Reactor provides a neutron flux of 10^9, a gamma ray flux of 10^6.

The Laboratory Reactor (LR) is a 5-watt, solution-type nuclear reactor. It can be operated and maintained by one person. It is 8-feet high, 8-feet in diameter. Power requirements are 110-volts at 60 cycles. It is completely fabricated at the factory and shipped as a unit—manufactured and installed in about 6 months. It has a wide range of applications.

As a laboratory instrument for research programs, the LR permits qualitative analysis by the neutron activation method—including measurement of coatings on metals, moisture testing, and liquid level monitoring. It will produce more than 100 different radioisotopes, about 40 of which have half-lives short enough to eliminate the need for costly contamination controls and waste handling systems.

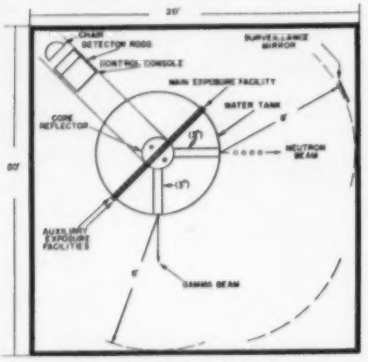
The LR can perform medical research functions such as genetic mutation studies, tracer research on plants and animals, radiation chemistry, and testing by the danger coefficient method. Equipped with facilities to conduct several experiments simultaneously, the reactor is ideally suited as a teaching tool in nuclear engineering, nuclear physics, radiochemistry and radiobiology. The basic behavior of neutron chain reactions, response to control elements, and the effect of delayed neutrons are a few of the 40-odd experiments that can be performed on the Laboratory Reactor.

The core of the reactor is a stainless steel sphere with an overhead convection recombiner. The fuel is uranyl sulphate enriched in uranium 235. The core is enclosed in a 6-inch lead reflector-shield. The complete 3500-pound unit—32" high, 24" wide—is centered in an 8-foot tank filled with water which serves as a biological shield.

The gas recombining system is contained in the core tank. A cylindrical screen above the core solution holds platinized alumina catalyst pellets which recombine hydrogen and oxygen gases formed during reactor operation. These fission product gases—valuable in experimental programs—can be withdrawn from the core through special gas lines.

The LR operator handles all controls and detection equipment from a control console adjacent to the reactor. Two cadmium control rods move vertically through the core—driven by electric motors manually controlled by the operator. The lead-weighted rods are attached to an electromagnet which releases automatically to let the rods fall by gravity into the core and shut down the reactor in event of a scram.

Instrumentation provides safety, low-cost and flexibility. At startup, three boron-lined neutron counters are fully inserted in detection tubes in the water tank. As power level increases, the operator withdraws the counters. Rate circuits—adjusted in response time constants—provide two ¼-second circuit channels for safety and observation and one 2-second channel for accurate power recording.



The LR can be installed in a 20×20-foot floor area.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. If you are interested in the LR—or any phase of reactor development—ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write, Director of Technical Sales, Dept. PE-71, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

*F. O. B. LOS ANGELES

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

For more data circle 522 on Post Card

J. R. P.
Here is an inexpensive, rugged forged steel valve that is quality-controlled to meet the highest standards
E. B. J.

ROCKWELL BUILT
Edward Valves

Large size knobbed handwheel eases operation.

Deep, full-size stuffing box and Evalpak packing combine to minimize maintenance.

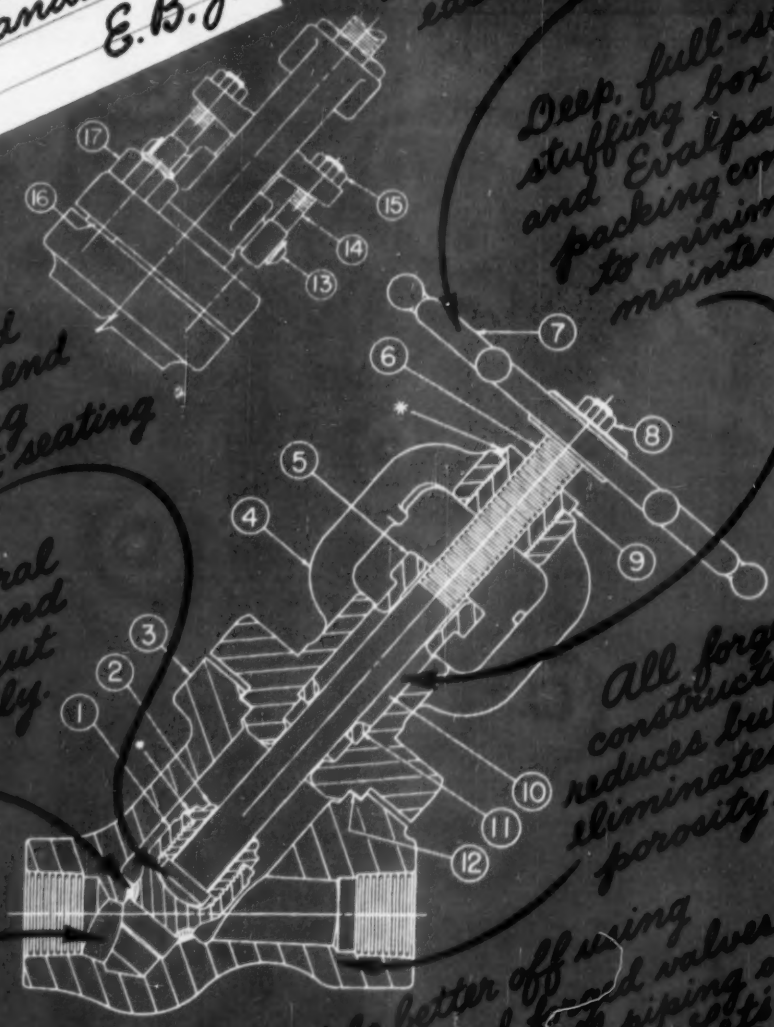
Swivel disk and radiused stem end prevent galling insure perfect seating

Edward integral Stellited seat and Stellited disk cut repairs sharply.

Straight through flow minimizes turbulance and pressure drop.

All forged construction reduces bulk-eliminates porosity.

We'll be better off using Edward forged valves for all small piping on our job. Let's get a bid.



LIST OF MATERIAL
QUANTITIES ARE FOR 1 GLOBE OR 1 ANGLE VALVE
WHERE A.S.T.M. SPECIFICATIONS ARE INDICATED THE LATEST REVISION APPLIES

PIECE NO.	NAME OF PIECE	NO. REQ'D	MATERIAL	SPECIFICATIONS	EDWARD MS NO.
1	DISK	1	FORGED ALLOY STEEL STELLITED	A.S.T.M. A182, GRADE F11	227
					485
2	DISK NUT	1	STEEL	A.I.S.I. C1120	125
3	BODY	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111 / 483
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227/483
4	BONNET	1	FORGED STEEL (a)	A.S.T.M. A105, GRADE II	111
			FORGED STEEL (b)	A.S.T.M. A182, GRADE F11	227
5	GLAND	1	MALLEABLE IRON	A.S.T.M.A220, GRADE 45004	324
6	STEM	1	EVALLOY	A.I.S.I. GRADE 416	761
7	HANDWHEEL	1	MALLEABLE IRON	A.S.T.M.A47 GRADE 32510	322
8	STEM NUT	1	STEEL	A.S.T.M.A194 - GRADE 1	124
9	YOKE BUSHING	1	BRONZE	A.S.T.M. B62	412
10	PACKING RINGS		EVALPAK	HIGH TEMPERATURE PACKING	501
*11	JUNK RING	1	STEEL - EVALIZED	A.I.S.I. C1120	125
12	BONNET GASKET	1	IRONKOTE		505
13	GLAND BOLT WASHER	2	STEEL		
14	GLAND BOLT	2	FORGED STEEL EVALIZED	A.S.T.M. A105, GRADE II	111
15	GLAND BOLT NUT	2	STEEL-EVALIZED	A.S.T.M.A194 - GRADE 0	125
16	TAP END STUD	4	ALLOY STEEL (c)	A.S.T.M.A193	
17	BONNET STUD NUT	4	STEEL (c)	A.S.T.M.A194 -	

EDWARD VALVES, INC.
SUBSIDIARY OF ROCKWELL MANUFACTURING CO.
EAST CHICAGO, INDIANA

FORGED STEEL
GLOBE AND ANGLE VALVES

DRAWN		DRAWING NO.
CHK'D		AE-3529-2
APP'D	DATE	

Edward builds Globe and Angle Stop, Non-Return, Check, Stop-Check, Gate, Blow-Off, Mudline, Relief, Hydraulic, Instrument, Gage, and Special Valves and Strainers.

First
Research-Cottrell
"Double-Deck"
Fly Ash Precipitator

Space was a big problem in this installation at the Burlington Generating Station of Public Service Electric and Gas Company of New Jersey. Two integral combination mechanical-electrical precipitators, large enough to handle 600,000 cfm of gas from Boiler No. 7, had to be squeezed into the smallest possible ground area.

If a conventional side-by-side arrangement had been used, these two units would have required about 1,700 square feet. By "stacking" the two combination precipitators, one on top of the other, Research was able to cut this space requirement by 50% — a saving of 850 square feet.

Although this arrangement had never been attempted with Research fly ash precipitators, Research knew from their experience with more than 500 central station Cottrells that it could be done. Guaranteed for 97% collection efficiency, these Burlington Generating Station units were placed in operation in October, 1955.

Perhaps you, too, have a knotty problem that demands a more creative approach — backed up by experience with over 500 fly ash precipitators. Whether you require a straight precipitator or a combination unit, at Research-Cottrell you can be sure of the most economical solution to your problem.

Other Research-Cottrell Precipitators at Public Service Electric and Gas Company of New Jersey

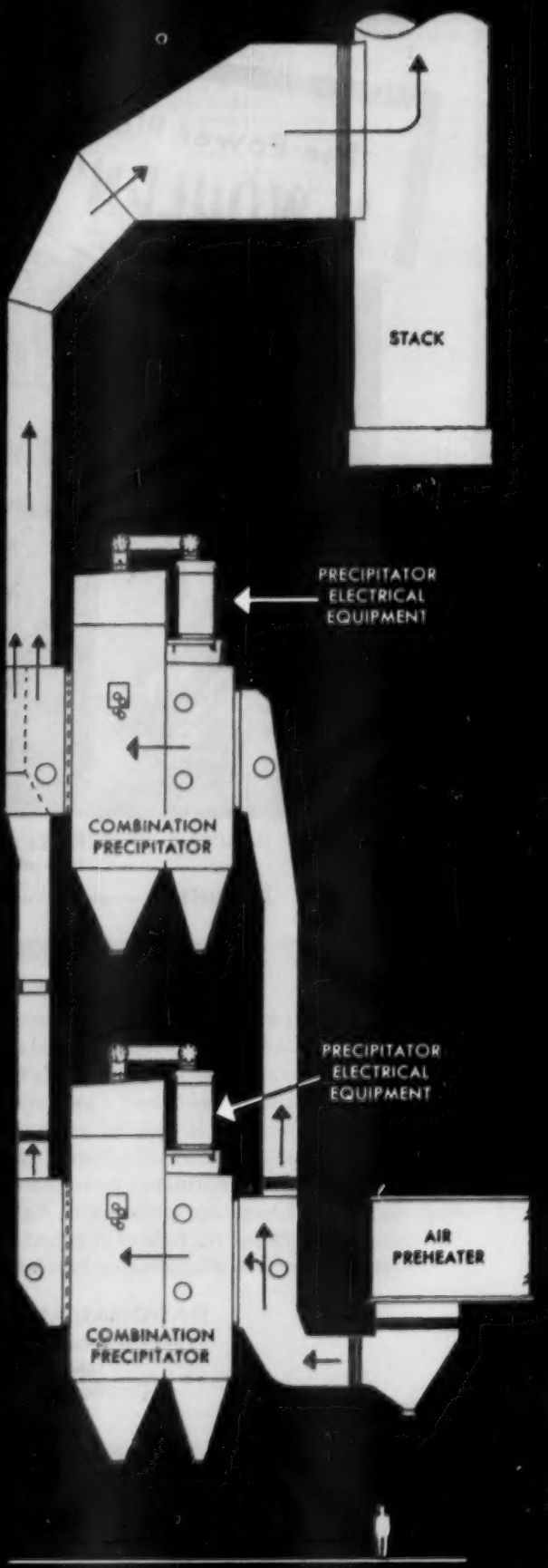
Installation Date	Generating Station	Boiler Number	Number of Pptrs.	C. F. M.
1937	Burlington	11	1	270,000
1938	Essex (Newark)	25 and 26	4	520,000
1940	Burlington	12 and 13	2	448,000
1941	Marion (Jersey City)	51 and 52	2	448,000
1942	Burlington	14 and 15	2	448,000
1946	Kearny	1 (Mercury Blr.)	1	160,000
1947	Essex (Newark)	1	3	380,000
1955	Burlington	7	2*	600,000
		Total	17	3,274,000

*"Double-Deck" Arrangement

Research-Cottrell, Inc.

Main Office and Plant: Bound Brook, New Jersey • 405 Lexington Ave., New York 17, N. Y.
Grant Building, Pittsburgh 19, Penna., 228 No. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.

Research-Cottrell's "double-deck" combination precipitators installed at Burlington Generating Station of Public Service Electric and Gas Company of New Jersey. At right, the simplified drawing shows the arrangement of the two integral mechanical-electrical collectors.



INQUIRING REPORTER: So you use Nalco System water treatment ... How often are your boilers turbined?

ENGINEER: I wouldn't know—only worked here seven years.*

* You recognize the Engineer's answer as a twist on the old one about *How-often-do-you-get-a-raise-around-here.* Our excuse for bringing it up is that the engineer's answer applies to hundreds of plants using Nalco water treatment. New plants, starting boilers from scratch with Nalco, report years on line, *billions* of pounds of steam generated in boilers that have *never* been turbined ... and probably never will be. Older plants, where turbining was as routine as checking the draft gauges, now open boilers only to show the inspectors.

These Nalco *results* can quite possibly be duplicated in your plant, regardless of the kind or severity of your water treatment problems ... or the size of your operation. Write or phone, now, for a fast start toward permanent water treatment security.

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HELPFUL BULLETINS

LIGHTING, COMMUNICATION

101 Prescribed Lighting — This 28-pp booklet, "Prescribed Lighting Protects the Eyes of Industry," features safety and visibility factors: standards for use in prescribing plant lighting; uses of fluorescent, incandescent and mercury vapor lamps; lighting of other areas; maintenance; data on fixtures. Discussing lighting as a production tool, booklet outlines related visibility factors of size, contrast, time and brightness, and lists 10 advantages gained from improved lighting. Sylvania Electric Products Inc.

102 Fluorescent Ballasts — Bulletin GED-2416B, 12 pp, contains cross reference information for general line, rapid start, slimline, instant-start, and circline ballasts — all 60 cycle. The pocket-sized booklet lists other manufacturer's catalog model numbers comparable to company's designations referenced according to application requirements. General Electric Co.

103 Annunciator Systems — Self-policing visual and audible annunciator systems are illustrated and described in this 20-pp catalog. In addition to listing the alarm systems, it also contains detailed information on what to consider when selecting an annunciator, wiring diagrams for alarm units, sample alarm sequences which may be common to many plants and other engineering and installation data. Scam Instrument Corp.

INSTRUMENTS AND CONTROLS

104 For Process Control — Catalog 2, 32 pp, describes company's process control instrumentation, including indicating, recording, controlling, and transmitting instruments for flow, pressure, and density. Capacities and dimensions are shown on tables, and pressure specifications, sizing nomographs, and other pertinent information included. Fischer & Porter Co.

105 pH Control — Reprint R-87 is a 10-pp article discussing the various types of industries which require some form of industrial pH waste treatment. Various processes are discussed and methods of overcoming difficult problems noted. Engineering aspects of continuous pH measurement are reviewed, and diagrams and graphs clarify details. Scientific Instruments Div., Beckman Instruments, Inc.

106 Temperature Regulators — Bulletin TR-57 describes the construction and function of company's 650 Series of temperature regulators featuring a balanced type of construction and vapor pressure operation. Application information is included, as well as data on dimensions and weights, installation, servicing, and photos and drawings showing component features. Atlas Valve Co.

107 Liquid Meters — Sixteen-pp Bulletin OG-400, revised, offers new information on meter selection. Includes more complete temperature, viscosity, pressure and registration data along with additional illustrations, an explanation of various metering terms and explicit ordering instructions. Describes company's oscillating piston meters for a variety of chemicals and industrial liquids. Offers data on meter construction and explains, with aid of tables and charts, which case, piston and chamber are best suited for use with specific liquids. Meter and Valve Div., Rockwell Mfg. Co.

108 Temperature, Pressure Recorders — Catalog 1021 features descriptive information on temperature and pressure recorders. Advantages are detailed, construction features illustrated with cutaway view, and specifications included. Penn Instruments Div., Burgess-Manning Co.

109 Pressure Gages — Bulletin DH-23 features manufacturer's line of pressure and chemical gages for such services as engines, turbines, blowers, locomotives, hydraulic presses, tractors, pumps, and compressors or wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations. The movement is illustrated and described and advantages pointed out. Helicoid Gage Div., American Chain & Cable Co., Inc.

110 Potentiometer Pyrometer — Eight-pp Bulletin 9B describes the improved Pyrotest, a portable potentiometer pyrometer with interchangeable direct-reading scale which checks and calibrates all types of thermocouple-actuated temperature instruments, and many electrical instruments. Photos of external and internal views showing component features are included, as well as full specifications. Technique Associates.

111 Furnace Temperature Control — Publication GER-1206, 21 pp, illustrated, consists of series of six articles on temperature control of heat treating furnaces. Discussed are basic temperature control systems, thermocouples and control instruments, control elements, and special systems. General Electric Co.

112 Thermal Conductivity Analyzer — Bulletin 56-1008-59, 12 pp, explains principle, construction, operation and features of the Condu-Therm analyzer and the Acratron electronic recorder, for use in determining amount of CO_2, H_2, He, CH_4, etc. Contains special section on gas sampling systems and how and why this analyzer is used. The Hays Corp.

PUMPS, COMPRESSORS

114 High Pressure Pumps — Eight-pp Catalog HP-1254 describes and illustrates company's Series HP controlled-capacity pumps for pressures to 35,000 psi and capacities to 2000 gph. Selection charts are provided for models with crank arm drive and yoke drive, along with application suggestions. Series HP pumps include some 208 models in three basic pump frame sizes for 2-, 3-, and 4-in. pump strokes. Specifications and design features are discussed. Philadelphia Pump & Machinery Co.

115 Vertical Sump Pump — Bulletin 54-3-1420, 20 pp, describes company's Sumpmaster line of vertical sump pumps. Typical installations are illustrated, and complete selection tables, dimensions and other data are included, along with sectional drawings. Byron Jackson Co.

116 Fuel Oil Pump, Heater — Preparation methods of heavy oil for combustion, and packaged fuel oil pump and heater sets are described in illustrated Bulletin 15. Covers application and construction features and tells how pre-packaged design makes installation easy and economical. Engineering data table shows recommended unit sizes for various burner capacities. Walter H. Eagan Co. Inc.

117 Air Compressors — Bulletin A-62, 20 pp, covers construction, operation information on company's class WN-112 heavy-duty air compressors. Illustrates five models of compressor, for displacement capacities from 368 to 974 cfm at sea level, and four high altitude models for 532 to 1100 cfm. Joy Mfg. Co.

ELECTRICAL EQUIPMENT

118 Protected Motors — "Total Protection" — a new concept in protected enclosures for industrial a-c motors — is graphically described in Bulletin B-2501. Cutaway views of motor and its components show how it is designed for applications which formerly required drip-proof or splash-proof motors, yet is guaranteed to operate within a maximum temperature rise of only 40 C. Reliance Electric and Engineering Co.

119 Excitation Systems — A comparison of four basic types of automatic excitation systems for turbo-generators is given in 8-pp Bulletin O5R8530. Lists principal component parts used in each of the excitation systems and reveals their advantages and limitations. Allis-Chalmers Mfg. Co.

120 Emergency Transformer Capacity — Ways to utilize hidden transformer capacity during a long shutdown of a large power transformer are described in 8-pp Bulletin O1R8529. Pointing out that transformer temperature determines its capacity, various methods of cooling the unit are described, including dual cooling system. Allis-Chalmers Mfg. Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 131 and 132.

121 Enclosed Breakers — Catalog 1-155, 20 pp, describes standardized new types of AB-I enclosed circuit breakers with 600 v ratings ranging from 15 to 600 amp. Text, illustrations and tables supply complete data covering the range of available AB breakers and enclosures, purchasing information, optional accessories and application. Application information, knockout and dimension data are also included. Federal Pacific Electric Co.

122 Outdoor Breakers — Design features of company's intermediate outdoor oil circuit breakers in ratings of 14.4 kv to 69 kv, 500 mva to 3500 mva, are described in Bulletin 71B8475A and its supplement. Includes a description of the Pneu-Draulic operator, previously available only on company's large tank type breakers, and portable power operated hydraulic tank lifter along with portable battery operated unit for use on breakers with pneumatic or solenoid operators. Allis-Chalmers Mfg. Co.

123 Packaged Substations — Bulletin 8B1, 28 pp, describes company's packaged steel substations for a variety of distribution applications. Typical bills of material for each design are shown for various operating voltages. Engineering, ordering and shipping method is explained and basic information on structural strength and structure foundations plans is included. Line Material Co.

124 Non-Metallic Cables — This 40-pp catalog discusses composition, properties, and suggested applications of company's Type RR rubber-insulated-Neoprene sheathed non-metallic cables. Provides evidence of "weathering" properties of the cables when exposed to sun, water and soil conditions. Individual treatment is accorded to 600-v underground service cables, 600-v duct cables, and high voltage cable and station control cable. Charts give data on size, strand construction, insulation sheathing, shipping weights. Current carrying capacities are also given. National Electric Products Corp.

125 Varnished-Cambric Cables — Bulletin VC-56, 22 pp, covers varnished-cambric cables in a voltage range of 600 to 5000 v for single and three conductor cables braided or lead sheathed. Armored cable constructions in both galvanized steel armor and aluminum armor are shown in 3 and 4 conductors. The engineering data section covers such items as conductors and conduits, insulation thickness, tests, braid and finishes, shielding, lead thickness, armored cable racks and components, terminators for interlocked cable, electrical circuit formulae. Rockbestos Products Corp.

126 Improved Panelboards — Sixteen-pp Bulletin 1-160 describes new techniques for more efficient design and installation of industrial and commercial panelboards. Provides data on plug-in StA Breakers and enclosures for lighting and power distribution. Bulletin provides information necessary to selection of components for distribution panelboard, and includes knockout data. Federal Pacific Electric Co.

127 Floor Outlet Box — Described in illustrated Form 553 is a modernized flexible outlet box designed for use in the floor, available in sizes ranging from a minimum height of 2⅝-in. to 3¼-in. Included are dimensional data, photos and descriptions of component parts and service fittings. National Electric Products Corp.

128 Insulating Tapes, Fabrics — Insulating tapes and fabrics facts are fully detailed in loose-leaf Booklet B-1050. The series of bulletins covers varnish and shellac treated papers, organic varnished fabrics and combination insulations, organic varnished glass fabric insulations, Class A and B, silicones varnished and silicone rubber coated insulations, Class H, and special insulations. Covers standard items of varnished papers, cambrics, and glass fabrics, as well as several newer materials in Class B and H temperature ranges. Westinghouse Electric Corp.

129 Capacitors, Capacitor Blocks — Two bulletins on secondary capacitors and capacitor blocks are announced. Bulletin PC-7 describes a line of capacitor blocks rated 250 to 1200 kvar at 2400 to 7960 v, and gives weights, dimensions, ratings, accessories, and ordering information. Bulletin PC-3 describes secondary capacitors rated 3, 5, 7½ and 10 kvar at 240 v. Application data, design features, weights, dimensions, and ordering information included. Line Material Co.

MECHANICAL POWER TRANSMISSION

131 Sprag Clutches — How the sprag concept offers maximum clutch performance is detailed in 26-pp Catalog 104-C. Applications are fully described, typical mounting arrangements diagrammed, and engineering data, dimensions, installation and maintenance, and complete ordering information is included. Formsprag Co.

132 QD Sheaves — Catalog Section 83-A, 16 pp, lists 739 stock sizes of company's QD (quick detachable) sheaves, which are interchangeable with sheaves produced by other QD manufacturers. Gives dimensions and weights, describes features of standardized QD sheaves and provides instructions for both standard and alternate mounting of sheaves on shafts. Other data include standardized QD hub and keyway dimensions, listing of stock hub bores and keyways, sheave groove dimensions and tolerances and standardized interchangeable hub and sheave combinations. Fort Worth Steel & Machinery Co.

VALVES, TRAPS, FITTINGS

133 Air Release Valves — Bulletin 856 covers air release valves for venting air from hot water heating systems, venting air from chilled water cooling and air conditioning systems, and releasing air from industrial and municipal pipelines and other equipment as water mains, water filters, tanks, brine lines, etc. Describes operation, lists features, and gives specifications and capacities, as well as typical installation drawings. The V. D. Anderson Co.

134 Gate, Needle Valves — Forged steel gate and needle valves, specifically designed for the petrochemical, power and process industries are graphically described in 12-pp Bulletin DH-80. Lists material specifications, pressure-temperature ratings, working pressures, dimensions, and application of the units. R-P & C Valve Div., American Chain & Cable Co., Inc.

135 Packless Valves — Catalog F, 22 pp, describes packless valves for applications involving hazardous liquids and gases, as well as uses in nuclear energy installations. Each valve covered in detail contains a metal bellows as the packless feature. More than 20 cutaway views of different models are included. Detailed data on specifying and ordering, and charts on application and selection are provided. One chart lists resistance of various metals used in the valves to corrosive action of some 200 chemicals and gases. Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

136 For Steam Heating — Eight-pp Bulletin 1501A illustrates a line of steam heating specialties. These products include radiator valves, float and thermostatic radiator traps, inverted bucket traps, strainers, air eliminator air checks, and gages, for steam, oil, gas, and water. Specification data provided covers dimensions, weights, sizes and capacities. Dunham-Bush, Inc.

137 Tube Fittings — Advantages and applications of butt joint tube fittings designed for speed and simplicity of installation are described in 24-pp Bulletin 3061. Component features are illustrated and described and recommended maximum working pressures and other technical specifications are tabulated, with photos and dimensional drawings included. The Imperial Brass Mfg. Co.

. . . *Outstanding Among This Month's Catalogs*

138 Motor Selector — Bulletin B-2103-1, 12 pp, gives information on how to select a-c motors for specific applications. Included are such selection data as speed-frequency relationship, NEMA design classes, torque characteristics, NEMA current and torque values, frame selection tables, and dimension charts and mechanical modifications for frame sizes from 182 to 6085. Reliance Electric and Engineering Co.

139 On Silicone Products — In this 12-pp 1957 Reference Guide are described almost 150 commercially available silicone products, including several developed within the year. Products are grouped by usage (water-repellents, dielectrics, release agents etc.), to help you locate a material by what it does, as well as by what it is. Descriptions are brief and factual, with emphasis on charts, tables and graphs comparing various silicones with materials they are displacing. Dow Corning Corp.

140 Centrifugal Fans — Bulletin A-103, 64 pp, describes airfoil centrifugal fans engineered around a backward curved non-overload type centrifugal wheel utilizing a hollow sectioned aerodynamic shaped airfoil blade. Advantages of design are fully detailed, and specifications and performance tables included. Photos of various models, drawings showing standard drive arrangements, charts and tables, and dimensional diagrams complete the picture. Chicago Blower Corp.

DUST CONTROL

142 Industrial Dust Control — Sixteen-pp Bulletin 922, encompassing dust control equipment and accessories, describes importance of dust control in relation to reduced maintenance costs, employee morale, and commercial utilization of dust by-products. Outlines standards of control and efficiency in dust collection and lists component parts of an engineered control system. A typical case history shows benefits of dust control in handling a community relations problem. Drawings and photos accompany descriptive information on dust control equipment, including new self-cleaning cloth

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Drop forging techniques, resulting from more than a half century of pioneering and development by Vogt in the production of forged steel valves, impart matchless strength and safety to the new line of Vogt GP Valves. Made from killed, clean, fine grained open hearth steel billets, forging and treatment operations result in additional grain refinement and increased toughness.

GP Valves are setting new standards of performance in petroleum refineries, chemical plants, power plants, and related industries. Available in a complete range of sizes from ¼" to 2" and rated 800 pounds at 850°F. and 2000 pounds at 100°F.

Advt. No. 4 in a series describing the features of Vogt GP Valves.

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VALVES

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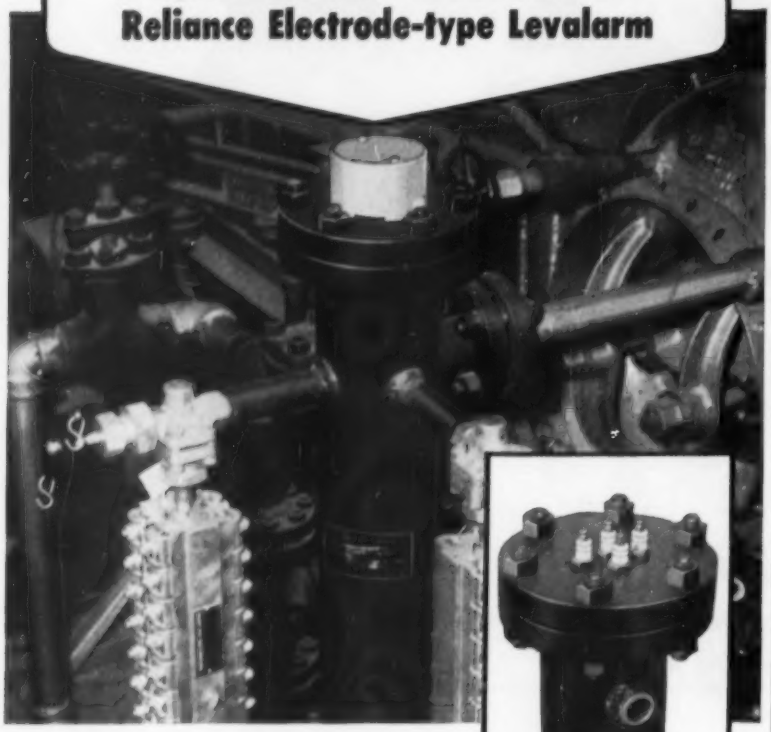
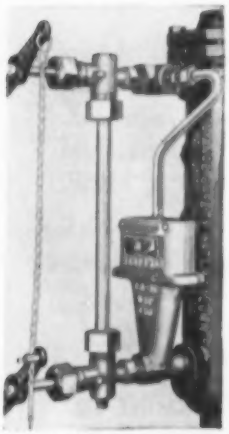
Here's all that shows of the Reliance Electrode-type Levalarm



Cap removed showing electrode connection fittings

Boiler water connects own alarm system and fuel cut-out . . .



Isolated circuits make relays work for you to actuate...

low water alarm — pump start
high water alarm — pump stop
fuel cut-out

(or selection of these facilities)

Upper photograph — Levalarm for pressures up to 2500 psi.

Lower photograph — Fuel cut-out Levalarm on water column. Can be installed in field.

Write for Bulletin D2.

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The name that introduced safety water columns . . . in 1884

Reliance®

BOILER SAFETY DEVICES

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screen collectors, various other types. Pangborn Corp.

143 Coal Dust Control — Bulletin 551-D discusses control of dust from coal and coke handling. Covers use of local exhaust ventilation and cloth-tube-type dust collectors. Four illustrated case histories included. Wheelabrator Corp.

WATER, WASTE TREATING

144 Zeolite Softeners — Twenty-pp Publication 4520 deals with necessity for water softening, explaining fundamentals of softening and selection of equipment and zeolites. Also describes operation of company's Hydromatic single control valve for manual or automatic control of the cycling of the process. Cochrane Corp.

145 Membrane Demineralizers — This 20-pp bulletin describes the electric membrane method of water demineralization. Provides design, performance and cost data on electric membrane plants ranging in capacity from 2,500 to 2,000,000 gal of demineralized water daily, and using input water containing from 1,000 to 10,000 ppm total dissolved solids. Ionics Inc.

146 Feed Water Deoxygenation — The advantages of chemical deoxygenation of boiler feed water with an aqueous solution of hydrazine are described in 12-pp Bulletin BW 5. How hydrazine serves to maintain boiler in cleanest possible condition, reducing iron oxide scale to a magnetic oxide, is fully detailed, and such considerations as economy and operation, handling precautions, containers and storage, and methods of analysis are covered. A bibliography of additional literature is also furnished. Fairmount Chemical Co., Inc.

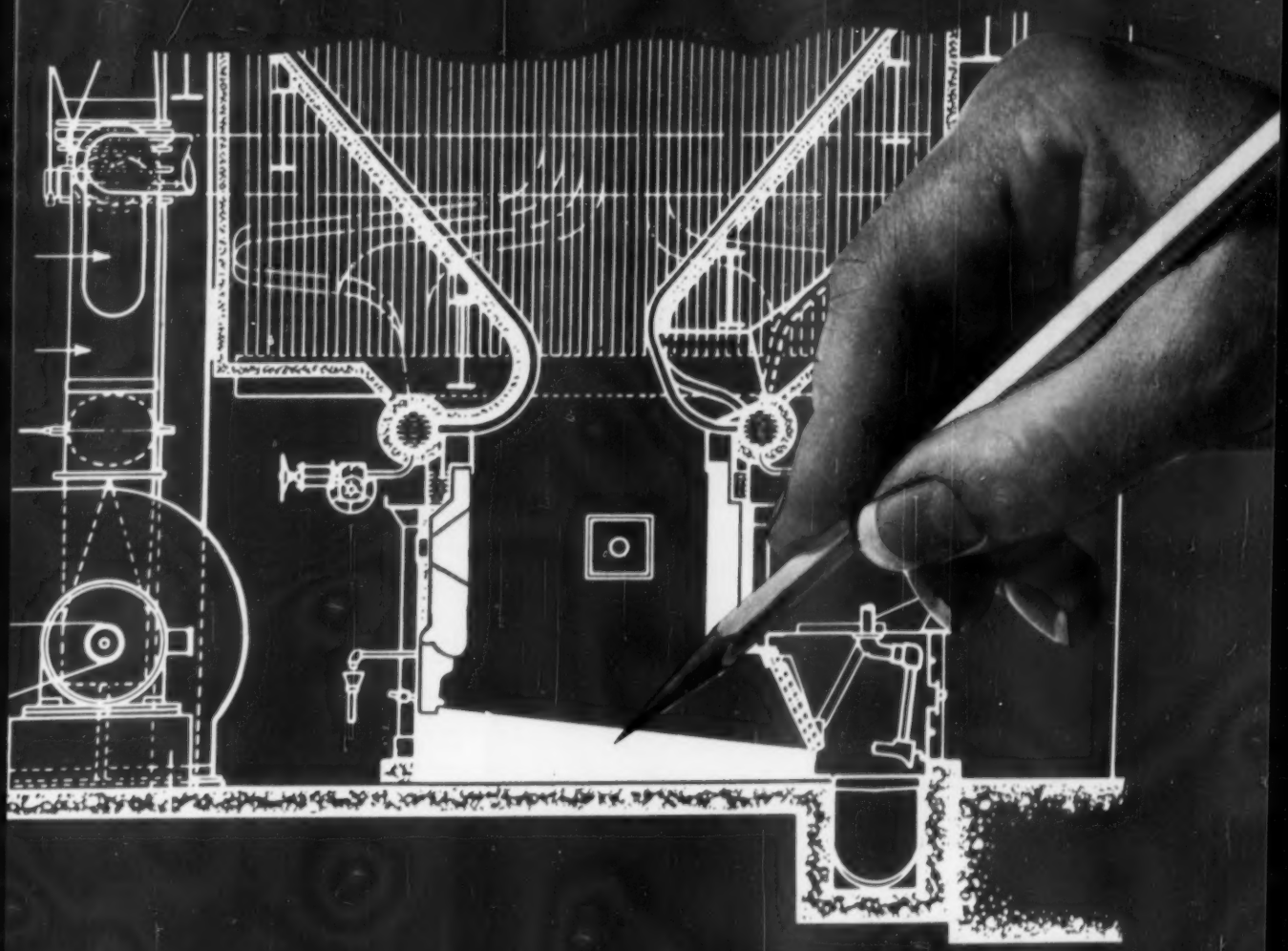
147 Water, Waste Treatment — Latest results in water, waste and sewage treatment entailing use of Separan 2610, a high speed flocculating agent, are reported in two booklets. The first offers data showing how Separan 2610 has improved clarity of treated water, increased solids settling rate, improved throughput of existing equipment, and decreased treatment costs. Methods of solution preparation and use are given. The other booklet tells how by using Separan metal finishing wastes handled on a batch basis in a 45,000 gal tank were settled in a third to a fifth of the time previously required. The Dow Chemical Co.

TOOLS

148 Electric Tools — Portable electric tools and kits with over 400 accessories for building, carpentry, plumbing and electrical work are described and illustrated in 32-pp Catalog 104. Includes over 150 pictures of tools and their uses with complete specifications for electric saws, sanders, drills, planes, routers, shapers, combination tools, grinders, hedge shears and grass trimmers. Porter-Cable Machine Co.

149 Cut-Machining Units — This 44-pp book describes briefly the various types of abrasive cut-off saws available, including a portable combination cut-off and deburring chop saw, a modular cut-off saw, a swing type cut-off saw, and a rotating cut-off saw having 12 in. pipe capacity, as well as portable hacksaw and bandsaw. Photos of the various tools in operation and complete specifications are included. Wallace Supplies Mfg. Co.

How to draw the line on ashpit maintenance



"Let's put Kaocrete here"

Relining ashpits is expensive and time-consuming. That's why more and more utilities and industrial companies are specifying a heavy-duty refractory castable such as B&W Kaocrete D. On job after job, it has withstood the heavy abrasive or erosive attack of sprays, jets, rakes or shovels.

The reason? Specially designed Kaocrete D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It saves time because it can be poured or gunned into place. For less severe abrasive or erosive conditions, B&W recommends Kaocrete A.

Get the facts and figures on these B&W Refractory Castables from your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

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R-549

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• CONTROL PANELS and DESKS

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FACILITIES, SERVICES

151 For Research, Testing — This 18-pp bulletin features descriptive information on facilities offered by this company for research and testing, including the hydraulics laboratory, chemical laboratory, combustion controls laboratory, fire test building, explosion chamber, impact test tower, high speed gage, explosion effect gage, continuous oxygen indicator, and construction materials calorimeter. Research accomplishments are enumerated and typical projects listed. Engineering Div., The Factory Mutual Companies.

152 Research Facilities — Twelve-pp Brochure 103-2M-956 describes research facilities available to industry on a contract basis. Services offered by this outside research staff in chemistry, chemical engineering, physics and mechanical engineering are explained, accompanied by case histories of recent research and development projects. Research Div., The Fluor Corp., Ltd.

153 Network Analyzer Facilities — A brief description of the facilities available to help solve system problems is presented in 8-pp Bulletin 18B8526. Points out that the company is a participant in the a-c network analyzers at two universities, and offers personnel skilled in the operation of the board to assist in assembling data and organizing results. A description of the operation of analyzers and types of studies possible is included. Allis-Chalmers Mfg. Co.

OTHER EQUIPMENT

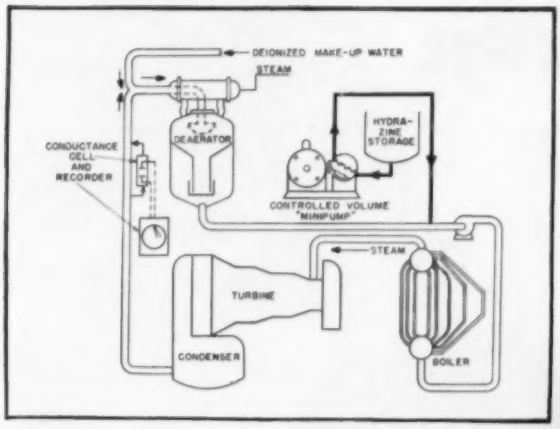
154 Air Conditioners — Bulletin 133 describes coil surface type air conditioners for industrial and commercial applications. Photos and diagrams covering units in capacities from 41,500 to 1,680,000 Btu per hr cooling range are included, as well as specifications. Niagara Blower Co.

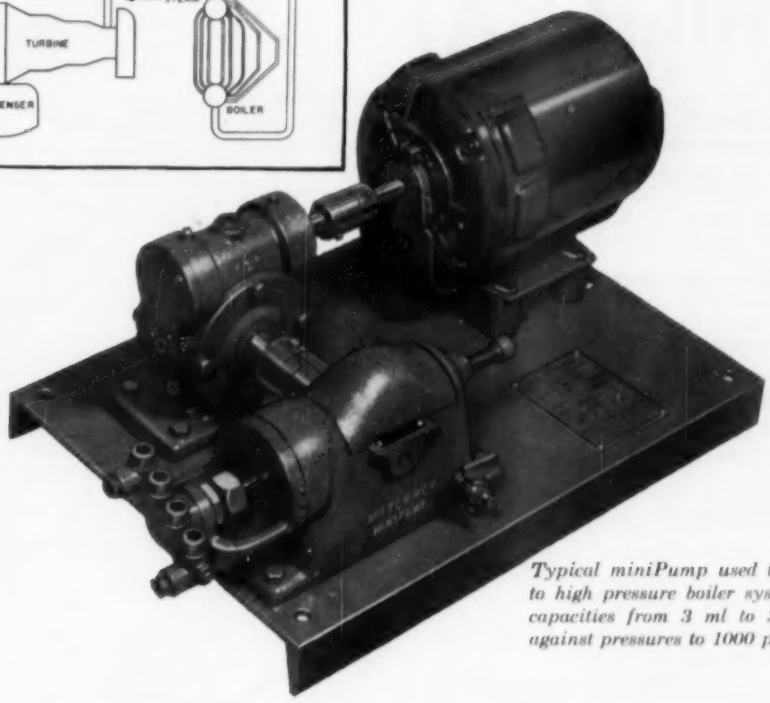
155 Corrosion Resistant Equipment — Catalog C-14, 32-pp, contains complete information on company's line of corrosion-resistant plastic equipment, including pipe and fittings, valves; fume ducts and fume systems; tanks, towers and accessory supplies; heat exchangers; pressure and vacuum equipment; and agitators. The booklet also includes data on chemical-resistant cements, the field construction of plastic equipment, and company's design service. Haveg Industries, Inc.

156 Duct Insulation Specs — These printed data sheets are offered to assist in writing of insulation specifications for heating and air conditioning duct systems. Punched for loose-leaf filing, the two data sheets detail approved specifications for attaching and finishing semi-rigid duct insulation. Three methods of attachment and four finishing techniques are described. Specifications for applying plain, vapor barrier and coated duct insulation are included. Baldwin-Hill Co.

157 Pulverizers — The Type MB planetary roll and table pulverizers are described in this illustrated brochure. Details such advantages as low power consumption, low maintenance, high reliability, ease of operation and control. A cutaway view and capacity and dimension table are included. Foster Wheeler Corp.

158 Boiler Tubes — Advantages found in company's boiler tubes are detailed in 20-pp V-9, No. 6 of their tube





Typical miniPump used to meter Hydrazine to high pressure boiler systems. Available for capacities from 3 ml to 3200 ml per hour, against pressures to 1000 psi.

Controlled Volume miniPump® accurately meters Hydrazine to treat boiler feed water

Residual oxygen in boiler feed water causes pitting and corrosion of pumps, economizers and steam lines. Add Hydrazine to the water, and this corrosive oxygen is removed. But it's not quite that simple. Too much Hydrazine liberates ammonia which will corrode admiralty metal tubes in condensers and heat exchangers. Effective feeding of Hydrazine in small quantities (.005-.030 ppm) calls for the accuracy of a Controlled Volume miniPump.

The pump, as illustrated in the flow diagram, meters from 0-225 milliliters of 3% Hydrazine solution in this 500,000-pounds-per-hour steam generating system. The pump controls the feeding of the additive from startup through running conditions. Capacity is adjustable from 0 to 100% of maximum by adjustment of plunger stroke length.

This is but one example of how Controlled Volume Pumps are rewardingly applied to water treating and other chemical metering jobs. Whatever your own requirements, check first with Milton Roy.

Milton Roy Company, *Manufacturing Engineers*, 1300 E. Mermaid Lane, Phila. 18, Pa.

milton Roy
CONTROLLED VOLUME PUMPS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

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COOLING TOWER POWER GOES HIGH HAT

Putting the fan cylinder to work, making it a functional part of the tower, is Marley's latest achievement that brings a new look to industrial cooling towers. As an integral part of Marley tower power the new **VL** (vertically laminated) **Fan Cylinder*** has a job to do beyond merely discharging exhaust vapor at high elevation to minimize the hazard of fogging . . . IT AMPLIFIES FAN EFFICIENCY AND COOLING PERFORMANCE.

The distinctive **VL** contour is dictated by tested, scientific design that increases air volume by recovering velocity pressure . . . simply making more air do more cooling. To engineers specifying new equipment, this is an added and important assurance of Marley's ability to deliver full, testable performance on every cooling tower installation.

As modernization equipment for existing towers, **VL** fan cylinders positively reduce water cooling cost in any of three ways:

1. Cooling a greater volume of water at specified temperatures without added fan horsepower.
2. Cooling specified volume of water at specified heat load to lower temperature without added fan horsepower.
3. Reducing required horsepower for any specified performance.

VL fan cylinders are safe, sturdy units. Laminated construction provides a rugged design which assures long, trouble-free service. Bolted laminated bands and integral truss bracing result in a unitized packaged assembly independent of tower framework for structural stability. Safety to operating personnel is provided by the strength and height of the cylinder and by the large access door permissible only in **VL** design.

Founder Member—
Cooling Tower Institute

The Marley Company

MARLEY Kansas City, Missouri

*U. S. Patent No 2681179

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bulletin. Dimensions and weights, and chemical analyses of stainless steels are shown on tables, and decimal equivalents included. A. B. Murray Co., Inc.

159 Silicone Lubricants — Eight-pp Code 6-101 is a comprehensive brochure describing silicone lubricants available in quantity. Properties and performance of various silicone oils, greases and compounds are discussed, and typical applications listed and illustrated. Attention is given to high speed, high temperature ball bearing problems, relative influence of bearing load, speed, metal combinations explained. Dow Corning Corp.

160 Retaining Rings — This 12-pp catalog lists 24 sizes in the industrial 1000 Series open type retaining rings for shafts measuring 1/25 in. to 1 in.; 37 sizes in 3000 Series internal retaining rings, for housings measuring ¼ to 2/16 in. in diameter; and 48 sizes in 3100 Series external retaining rings, to fit shafts from ⅛ to 2¼ in. Specifications and dimensional information included, as well as photos and drawings illustrating details. Industrial Retaining Ring Co.

161 Building Material Protection — How to lick industrial corrosion problems and permanently weatherseal building materials is told in this 12-pp reference catalog. Contains data on protective coatings and synthetic rubber compound. Explains how the coatings protect metal, masonry and wood against acids, alkalis, alcohol, oils, gasoline, solvents, salts and water; and how metal, masonry and glass are given a weathertight seal. Each product's features, functions, performance and instructions for application are outlined. David E. Long Corp.

163 Engine Applications — The first four of a series of engine case histories covering company's line of engines are offered in these four bulletins. Case histories include pictures and drawings to illustrate applications using the V-8 and V-12 engines of 540 to 4000 cu in. size. Applications described include air conditioning, gas boosting and others. Le Roi Div., Westinghouse Air Brake Co.

164 Castable Refractories — Advantages of company's castable refractories for a wide range of temperatures and process conditions are detailed in this 8-pp bulletin. Properties of the castable refractories are indicated on tables, as well as information on where the castables are used and how much to use. Refractory & Insulation Corp.

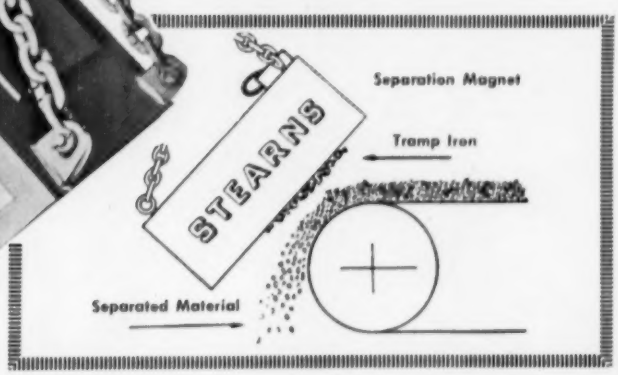
165 Boiler-Burner Units — Bulletin ID-56-215, 8 pp, details specifications for a line of packaged firebox boiler-burner units engineered for 4-pass fire travel and automatic operation with oil or gas or oil-gas combinations. Installation and operation advantages are illustrated and a large cutaway view showing component features is included. York-Shipley, Inc.

166 Storage Equipment — Reference Manual 485 is the 48-pp 1957 buyers' guide to this manufacturer's line of steel equipment. Presents all types of steel shelving, bins, drawers, lockers, work benches and tables, and other office, warehouse and shop equipment, including trucks. Fully illustrated, booklet shows features of each item, and provides dimensions, suggestions for use. Price list is given. Equipto Div., Aurora Equipment Co.

STEARNS SUSPENDED MAGNET

gives you cleaner coal —even on fast conveyors!

Magnet can be suspended at head pulley of conveyor, in position shown, or anywhere along the belt. At right, principle of operation of Stearns rectangular suspended magnet. Optional cable suspension for easier control of angle.



A Stearns rectangular suspended magnet gives you positive and efficient removal of tramp iron — even on heavily loaded, fast conveyor lines.

The Stearns rectangular magnet design permits its powerful, deep-penetrating magnetic force to remove tramp iron effectively from entire width and depth of material burden at belt speeds in excess of 600 fpm. The magnet operates efficiently where other equipment can't do the job — protects expensive crushing and pulverizing equipment against damage.

Greater Flexibility

Stearns suspended magnets overcome space limitations because they can be placed over head pulleys or anywhere along the belt. Magnets are economical to install and operate. There's no need to modify your existing conveyor systems.

Standard or Custom-Built

Magnetic specialists at Stearns design and build rectangular or circular suspended magnets, electro or permanent magnetic pulleys in standard sizes — or to your specifications. Get complete details from your Stearns representative.

17

Check these advantages:

- *All-welded, moisture-proof construction*
- *No moving parts that require replacement*
- *Single-coil construction for magnetic field stability*
- *New design of magnet coil enclosure affords maximum heat dissipation*
- *Vacuum-impregnated windings for long life, dependable operation*

FREE BULLETIN AIDS SELECTION

Send today for new bulletin describing five major types of Stearns suspended separation magnets. Gives you complete specifications and simple method of selecting the proper size and type of magnet for your application. Ask for Bulletin 1031-M.

STEARNS MAGNETIC PRODUCTS

A DIVISION OF THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

635 South 28th Street • Milwaukee 46, Wisconsin

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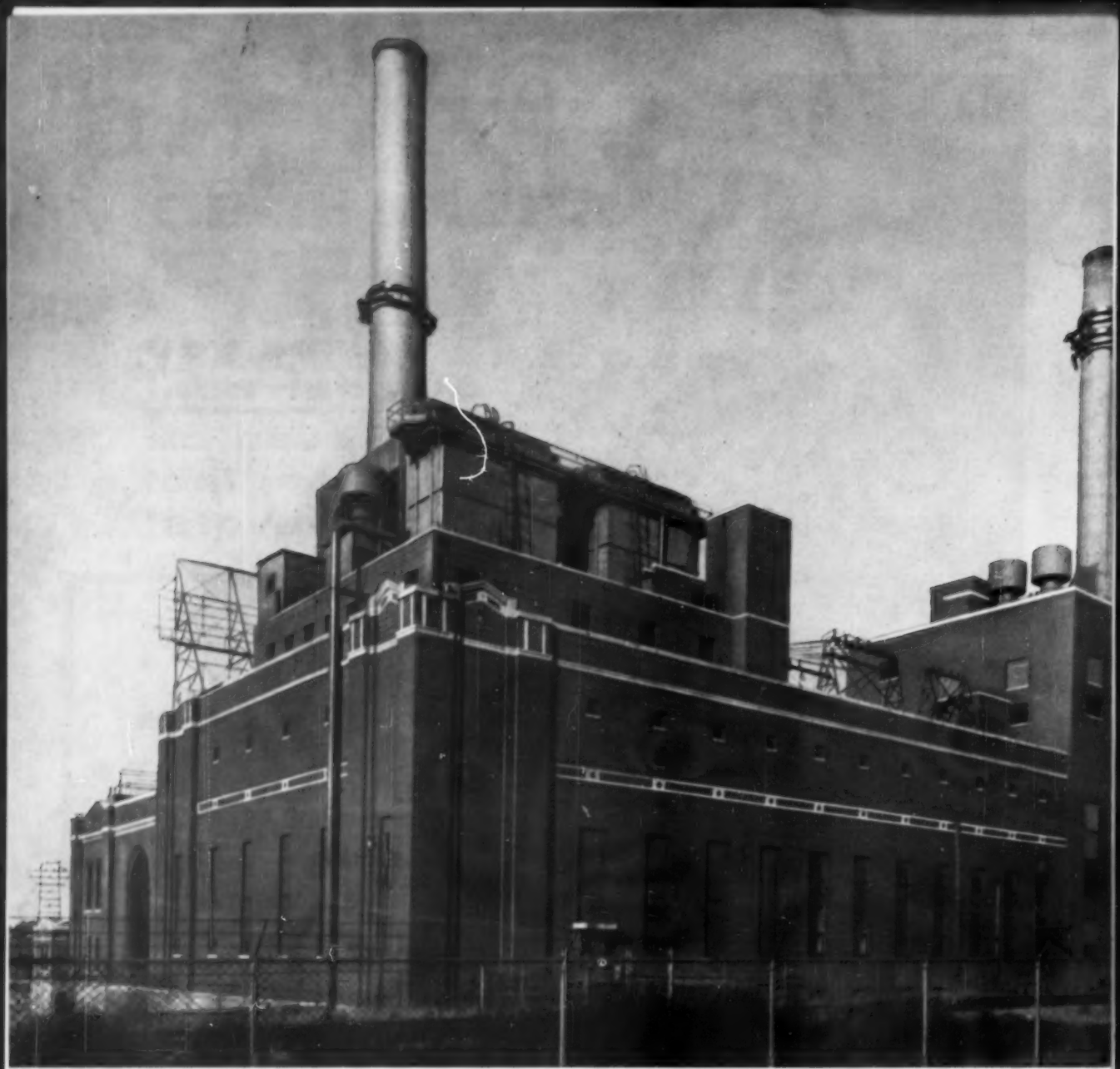
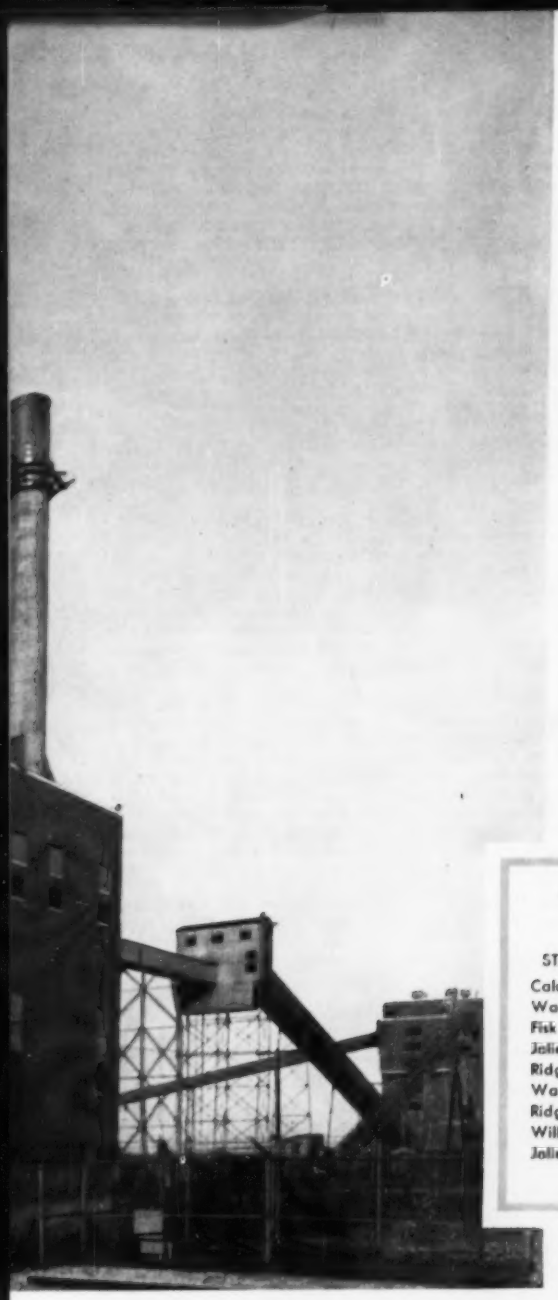


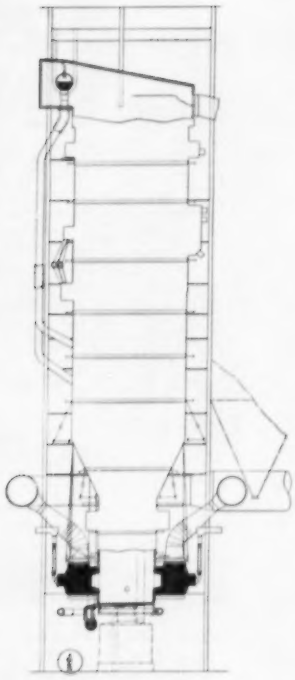
New Cyclone Furnace Unit

Installation at Joliet Station to Bring Higher Efficiency ...Lower Costs to Power Generation

Commonwealth Edison System's newest addition, at its Joliet Station, will be a B&W Radiant Reheat Boiler with Cyclone Furnaces. This is the 16th unit of this type the system has bought since 1944 and raises total system capacity served by Cyclone-fired units to over 1,600,000 kw.

Early in the development of the Cyclone Furnace by B&W, Commonwealth Edison recognized its potentialities for burning low-grade coals. The system's engineers and operators cooperated with B&W in the project, and, in September 1944, the





B&W RADIANT REHEAT BOILER WITH CYCLONE FURNACES, arranged for opposed firing, for Commonwealth Edison System's Joliet Station. Unit will deliver 2,200,000 pounds of steam per hour at 2100 psi with temperature of 1055 F, reheat to 1005 F. Boiler design is 2375 psi. Sargent & Lundy, Consulting Engineers.

CYCLONE FURNACE BOILER UNITS IN COMMONWEALTH EDISON SYSTEM

STATION	NO. OF BOILERS	NO. OF CYCLONES	TOTAL CAPACITY LB/HR	DESIGN PRESSURE	STEAM TEMP. F	REHEAT TEMP. F
Calumet	1	1	150,000	600	650	—
Waukegan	1	2	300,000	650	760	—
Fisk	2	8	1,500,000	1475	935	—
Joliet	2	6	1,200,000	1525	1010	—
Ridgeland	4	16	2,920,000	2125	1050	—
Waukegan	1	4	830,000	2050	1010	1010
Ridgeland	2	12	2,200,000	2125	1050	1000
Will County	2	10	2,400,000	2125	1050	1010
Joliet	1	9	2,200,000	2375	1055	1005
	16	68	13,700,000			

For Commonwealth Edison

first commercial application went on the line at Calumet Station. Historic Boiler Unit No. 20-A, like the new unit at Joliet, burns highly volatile Central Illinois coal with a high ash content and low ash-fusion temperature.

The Cyclone Furnace simplifies the entire process of coal preparation, combustion, ash segregation, and ash handling and effects savings in most of the elements of power generation costs.

In service or on order, 64 boilers with 220 Cyclone Furnaces throughout the country serve a total capacity of over 6,600,000 kw. They merit examination in connection with your next installation. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-820-C5

BABCOCK & WILCOX

BOILER DIVISION

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CONSTRUCTION NEWS

Hartford, Conn. — Connecticut Light & Power Co, 36 Pearl St, Hartford, Conn., has plans maturing for the expenditure of more than $100,000,000 between now and the end of 1959, for new electric plant and generating facilities. Territory served in the State of Connecticut is the fastest growing area in New England and company now serves better than 39 per cent of State area by population. Most of the amount of money allotted for expansion will go toward the purchase and installation of increased generating capacity. The balance will go toward substation, transmission lines and other miscellaneous expansion.

Wilmington, Del. — Delaware Power & Light Co, 600 Market St, Wilmington, Del., has arranged for the sale of preferred stock in the amount of $8,000,000, proceeds of which are to be used for extensions in plants and systems and other construction purposes in addition to paying off bank loans for previous construction.

Wilmington, Del. — Northern States Power Co, 100 W Tenth St, Wilmington, Del., has announced a program for the expenditure of approximately $221,600,000, for construction of new electric facilities through 1960. Company serves 520 communities in Minnesota, Wisconsin, and North and South Dakota, including Minneapolis and St. Paul, Minn. Improvements are planned in company's power generating facilities, including power substations, transmission lines and other operating facilities. Company has also allotted an amount in excess of $30,000,000, for improvement and expansion of its gas facilities.

Miami, Fla. — Florida Power & Light Co, 25 S Second St, Miami, Fla., has plans under consideration for the construction of a multi-million dollar electric power and generating station to be built in either Volusia or Seminole County in Florida, site for which is still under consideration. To keep up with the tremendous growth of the Cocoa, Fla. area, company proposes to erect Florida's first 240,000-v transmission line to connect the present plant on Lake Monroe at Sanford, Fla. with the South Florida operations. Cost of both projects are reported to be in excess of $20,000,000.

Miami, Fla. — Florida Power & Light Co, 25 S Second St, Miami, Fla., plans an expenditure of $66,000,000, for extensions and improvements in power generating facilities, power substations, transmission lines and other operating facilities through December 1957. Most of this construction money will go toward boosting company's 1,000,000-kw capacity by an additional 640,000 kw. Company has arranged financing in the amount of $15,000,000 to cover cost of this program and plans to raise an additional amount of $35,000,000 publicly sometime early in 1957. Florida Power's 1957 building budget at a record $66,-000,000, is an increase over last year's, of better than $23,000,000.

Evansville, Ind. — Southern Indiana Gas & Electric Co, 20 NW Fourth St, has filed with the Indiana Public Service Commission, an application for the sale of bonds in the amount of $5,000,000, proceeds of which are to be used to repay bank loans and construction costs in current construction program to improve company's generating stations, transmission lines and other operating facilities.

Indianapolis, Ind. — Indianapolis Power & Light Co, 17 N Meridian St, has announced a major expansion and improvement construction budget over the next three years totalling more than $47,000,000. The 1957 construction budget entails the expenditure of more than $16,659,000, for expansion and improvement of company facilities, including generating stations, power substations, transmission lines and other operating facilities. Company also has plans maturing for a 1958 budget of $14,-517,000 and for 1959, $16,000,000.

South Bend, Ind. — American Gas & Electric Co, subsidiary of the Indiana & Michigan Electric Co, has announced the construction of a new power plant to be located on the banks of the Wabash River, 20 miles southwest of Terre Haute, Ind., in Sullivan County. New plant to be known as the Breed Power Plant, named for one of the original founders of the company, will house a 450,000-kw generating unit, with provisions for additional expansion at a later date. Work is already under way and initial unit is scheduled to be placed in line sometime in 1959. New generating facility will represent an investment of $58,-000,000.

Shreveport, La. — Southwestern Gas & Electric Co, 428 Travis St, a subsidiary of the Central and Southwest Corp, Wilmington, Del., has filed with the SEC for permission to arrange for the sale of bonds totalling $10,000,000, proceeds of which would be used to pay off present bank loans and for construction costs of company's 1957 construction program. Company plans to spend $17,000,000 for improvement and expansion of generating facilities, power transmission lines and other operating facilities.

New York, N. Y. — Consolidated Edison Co, of New York, 4 Irving Place, has announced a proposal to purchase power plants now owned and operated by the City of New York, which would include the supply, under long-term contract, of the Transit Authority's power requirements for the operation of the city's subway lines. Arrangements are being made for a competent and impartial evaluation of the proposal from an impartial source, cost of which will be shared equally by Consolidated Edison and the City of New York. No amount for the transaction was specified but if sale is concluded it would involve better than $50,000,000.

Buffalo, N. Y. — Iroquois Gas Corp, 45 Church St, Buffalo, N. Y. has requested permission from the FPC for authority to take over the facilities of the Republic, Light, Heat & Power Co, of the same address. Both companies are subsidiaries of the National Fuel Gas Co, Buffalo, N. Y. Iroquois plans to acquire the Republic Company by trading, on a share for share basis, its $100 par common stock for the 96,746 shares of Republic's $100 par common. Object of the merger is to simplify corporate structure of the National Fuel Gas group of companies.

Prospect, N. Y. — Niagara-Mohawk Power Co, 300 Erie Boulevard West, Syracuse, N. Y., has announced plans for the construction of a new $5,000,000, hydroelectric power development, on West Canada Creek, just 14 miles north of Utica. Prospect development will include a dam 50 ft high and 300 ft long, a power generating plant, and a substation. A new high-voltage transmission line is planned to link new facility with company's plant downstream at Trenton Falls, N. Y. Construction of plant with an initial capacity of 17,350 kw will get under way at once and is scheduled for operation by late 1958.

Eddystone, Penna. — Philadelphia Electric Co, 1000 Chestnut St, Philadelphia, Penna., in line with company's $370,000,000 expenditure program between now and 1960, for expansion and improvement, has work under way on the installation of two giant turbine-generators, each with a capacity of 325,000 kw, at company's Eddystone Plant. The first unit is scheduled to be placed in operation by late 1959 and the second several months later, about mid-1960. These installations, together with a 175,-000-kw steam-electric generator, now under construction at company's Schuylkill Station in Philadelphia, will add 825,000 kw to system's capacity, increasing total output to better than 3,300,000 kw.

Knoxville, Tenn. — The Tennessee Valley Authority has announced that it is planning to build three additional steam plant units, to be paid out of power earnings, at a reported cost in excess of $74,000,000. Two of the units will be installed at the Johnsonville Steam Plant and one at the Gallatin Steam Plant, Gallatin, Tenn. These units are in addition to four others previously announced. Total cost of all seven units, to be financed out of TVA earnings, is estimated at $184,000,000.

Memphis, Tenn. — City of Memphis plans to arrange financing in the amount of $154,000,000 through the sale of tax-exempt revenue bonds to provide initial financing of new municipal power plant now under construction. Plans call for the sale at a later date of about $37,000,000 additional bonds in 1959, $41,000,000 in 1961, and approximately $45,000,000 in 1963. Plant will consist of three steam-electric, turbine-generator units, each with a nameplate rating of 250,000 kw to be constructed in sequence. Total net possibility of the three units serving the Memphis area including Shelby County will approximate 812,500 kw. The feasibility report states that the initial unit will be in operation by the summer of 1958.

Graham Station, W. Va. — American Gas & Electric Co, jointly owned and operated by the Appalachian Electric Power Co and the Ohio Power Co, has announced the second installation of two record breaking 450,000-kw installations at company's Phillip Sporn generating plant here. Construction and preliminary foundation work will get under way soon and is scheduled for completion in late 1959. Station's capacity will be increased to 1,050,000 kw, making it the third largest privately owned generating station in the country. Plant is situated near the geographical load centers of the system and a vast supply of low-cost coal reserves. Plant and equipment will cost an estimated $58-000,000.

LEADERSHIP IN ACTION

...includes MOGUL® plant water treatment service

Maintaining high pressure boilers free of scale, rust and corrosion is one of the many MOGUL water treatment services utilized at CATERPILLAR.

Meticulous craftsmanship and pride in a product assures leadership. For over 50 years world-famous CATERPILLAR products have been synonomous with quality in mechanical engineering originality.

Today, enormous manufacturing facilities are necessary to meet CATERPILLAR production schedules . . . millions of gallons of water are required daily for boilers, water supply systems, steam lines, dust collectors and other units at Peoria, Illinois.

MOGUL Water Treatment Service has proved safe and economical in maintaining a smooth and uninterrupted plant operation. MOGUL's 42 years of acknowledged leadership in plant water treatment has solved many water problems at CATERPILLAR . . . and could do the same for you!

We invite your inquiry relative to water treatment problems. Free-of-cost analyses and guaranteed results can be your reward.

SPECIALISTS IN INDUSTRIAL WATER TREATMENT FOR OVER 40 YEARS

Individual counsel and literature are available at your request.

The North American

MOGUL Products Company

Standard Building • Cleveland 13, Ohio

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 131–132 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—METERING INSTRUMENT can handle large flow rates

The By-Pass Rotameter is designed to permit economical measurement of large flow rates in pipe sizes of 2 in. and above. It utilizes most features of company's Rotameter instruments such as; linear response, wide range (up to 10 to 1), direct reading scale, and ability to handle corrosive fluids. Overload checks, seal pots and equalizing valves are not utilized. Further details are in Bulletin 116. Brooks Rotameter Co.

2—MULTIPLE OUTLET BOX with six replaceable sockets

Model MO is a heavy duty multiple outlet box containing six replaceable sockets, a neon indicator light, and an "on-off" control switch. These are mounted in a brown metal case. The 10-ft cord is described as rubber jacketed type, UL approved, and the a-c plug contains two fuses for equipment protection. The unit can be portable or mounted as a permanent arrangement. It is rated at 15 amp, 11 v. It costs less than $7.00 CBC Electronics Co., Inc.

3—SHEET INSULATION made of flexible, foamed plastic

Armaflex Sheet Insulation adapts itself to curved or irregular surfaces with little or no fitting or cutting, it is announced. It is formed from same basic material as company's Armaflex Pipe Covering,

already in use. The flexibility of the new sheet form Armaflex suggests its use in insulating large tanks, irregularly shaped vessels, oversize pipes and refrigeration and air-conditioning equipment. The material withstands temperatures to 160 F, with no limitation at the low end of the temperature scale, says company, since thickness can be built up by applying successive layers.

Armaflex sheets are reported to have a K factor of 0.28 at 75 F mean temperature and a water vapor permeability of 0.1 perm. They come in thicknesses from ½ to ¾ in. in 30-by-36 in. sheets, and are applied with an adhesive supplied by manufacturer. No vapor barrier is necessary, but company recommends that outdoor installations be suitably coated. Armstrong Cork Co.

4—INSULATING UNIONS for preventing electrolytic corrosion

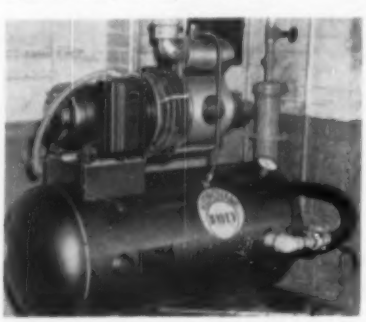
Insulating forged steel unions, used to prevent electrolytic corrosion due to flow of electric current along pipe lines, are offered in 3000 lb class, sizes ¼ to 3 in. in screw-end and socket-welding types. The tailpiece, thread piece and nut are drop forged from carbon steel, and the insulating sleeve, separating tailpiece and nut, is made of fabric-reinforced phenolic resin for high strength, toughness and chemical resistance. The gasket which seals the union joint, and which is in contact with the fluid in the pipe, is made of Teflon. W-S Fittings Div., H. K. Porter Co., Inc.

5—CLEANER for zeolite and other cation exchangers

Kleen-Ion is announced as a new ion exchanger cleaner. After continued use, zeolite and other cation exchangers may lose exchange capacity as they become fouled with precipitated inorganic materials, biological growths, mud and silt. Unless zeolite material has chemically deteriorated, Kleen-Ion will aid in cleaning the zeolite bed, manufacturer states, decreasing pressure drop caused by fouling and restoring the softening capacity. Kleen-Ion can also be used to keep the zeolite clean and prevent future fouling. W. H. & L. D. Betz.

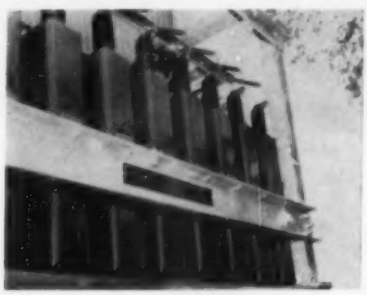
6—ROTARY COMPRESSOR is 5-hp tank-mounted unit

The Hydrovane has a displacement of 21 cfm, is direct connected to an 1800 rpm, 5-hp electric motor, and is available with modulation, start-stop, or combination modulation-start-stop control as desired. Maximum working pressure is 200 psi for continuous operation, 250 psi for intermittent use. Units are available with horizontal (shown) or vertical air receivers (tanks). Outstanding design feature of the Hydrovane is its "multi-thrust" rotor blade and contour-bored stator. This rotor-stator arrangement, in combination with two multi-stage cooling oil injection chambers, is said to compress air more efficiently, more quietly and with less vibration, and at a lower temperature than possible in many two-stage designs. Davey Compressor Co.



7—RACK EQUIPMENT with 50-kvar capacitors

Shown attached to its shipping frame, this assembled rack equipment with 50-kvar capacitors offers savings in weight, space and cost over previously



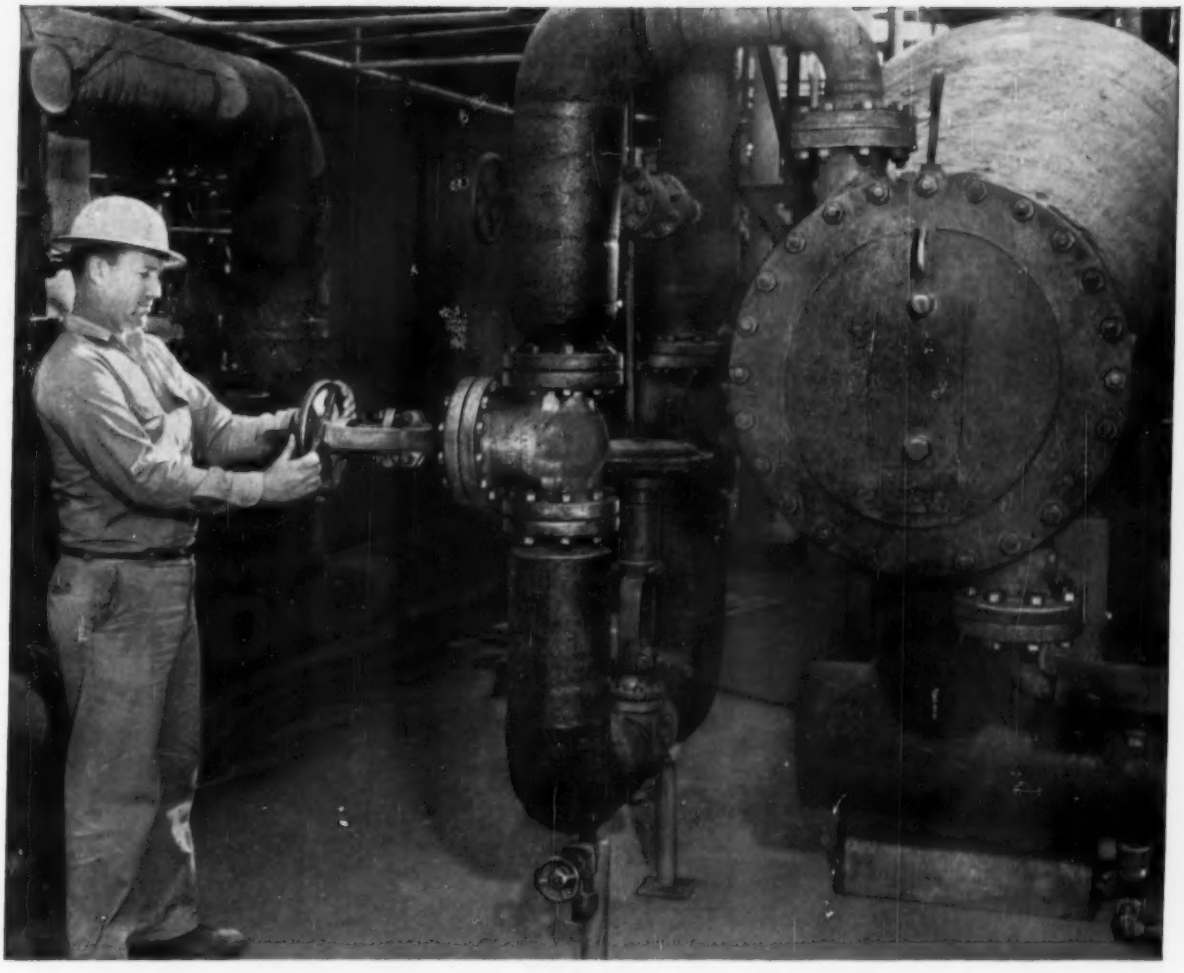
available racks utilizing 25-kvar units, according to manufacturer. The new racks come in sizes from 400 to 1200 kvar. The equipment can be applied to high voltage circuits up to 138,000 v and may be used at voltages under 15 kv to provide economical bulk kilovars. Buswork and connecting materials are copper to provide a low resistance path. Racks are shipped assembled, including buswork and individual indicating unit fuses. Four lifting lugs on each rack aid installation. General Electric Co.

8—PACKAGED LIQUID COOLERS are of multipass design

Employing the flooded refrigeration principle, these packaged liquid coolers are of multipass design and may be used effectively for handling viscous or slurry type liquids. The package includes a complete refrigeration cycle, compressor, motor and starter, refrigerant controls, liquid cooler, condenser, piping, wiring and insulation, shop assembled and tested, ready for installation and operation. The units are available in sizes from 5 to 100 hp. The Doyle & Roth Mfg. Co., Inc.

9—DEFLECTION HANGERS for equipment, piping

Vibro-Hangers, for suspending disturbance-generating equipment and piping systems, are designed to provide maximum freedom from vibration transmission. As the high-deflection vibration-isolating medium, these hangers utilize a helical steel spring designed to withstand high temperatures without permanent set, and low temperatures without loss of resiliency. According to manufacturer, these isolation units provide greatest deflections and load capacities available, and are suited for eliminating transmission of vibration and noise where low frequency disturbances are present, where extremes of



This Crane valve joins the "12-year service club" on steam

Valve performance like this looks good on any plant's cost sheets.

In 1944, Eastern States Petroleum Company installed this Crane 4-inch 33XR steel gate valve in its Houston refinery, handling 150 pounds of steam at 375° F. It's a busy valve—operation is frequent.

Despite the fact that this Crane valve has an even dozen years of service—with opening and closure at close intervals—*no* maintenance or service has been required except repacking.

Before you lift an eyebrow in surprise, consider the fact that Crane valves have performance records like this throughout industry, on all types of flow control. There's a logical reason, of course: Crane valves are strictly quality *all* the way—from research and engineering through precision manufacturing, assembly and testing methods.

Any wonder why men who know valves say *Crane is the name to depend on?* Don't gamble with your all-important flow control—specify Crane valves and fittings from the world's largest line, built with a century of matchless experience. Get the facts from your local Crane Representative, or write to the address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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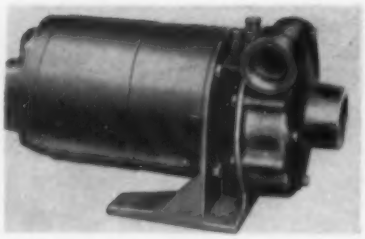
temperature are encountered, or where the equipment is installed in critical locations. Effective load range is from 50 to 3800 lb. The units are supplied without housing, with box- or bracket-type housings. The Korfund Co., Inc.

10—BOILER FEED PUMP MOTOR makes less noise

A sharp reduction in operating noises of this 3600-rpm boiler feed pump motor has been accomplished through a new design minimizing sound level both over-all and throughout the various octave bands. High frequency sound levels are reduced by sound absorbing material and baffling, while low frequency sound is quieted through stiffening of stator frames. Available in 1000 hp and up, the new design also includes features for reduced maintenance, easier inspection and longer motor life. Inspection of bearings and stator windings is made easier by horizontally split cast iron end shields and air deflectors, and by removable top section and cover plates on each side. Feeler gage openings on end shield make it easier to measure air gap. A new bearing sealing system also contributes to reduced maintenance. Static pressure is maintained on both sides of bearing to eliminate oil leakage, and slinger and labyrinth seals give added protection. Features which reduce noise are a series of noise traps inside cover, a special arrangement of rotor and stator slots to reduce magnetic noise, and a change in number of rotor fan blades. General Electric Co.

11—METALLIZING POWDER for rebuilding crankshafts

Colmonoy C-250 is a metal powder developed specifically for rebuilding engine and compressor crankshafts by the metallizing process. Anti-friction qualities of the surface produced by this powder are said to enhance horsepower delivered and contribute to longer crankshaft life. The material is a high chromium-nickel powder containing chromium borides. It features a low coefficient of friction, controlled surface porosity and good oil retention, says company. Wall Colmonoy Corp.



13—CENTRIFUGAL PUMPS are single stage, close coupled

Announced as ideal units for air conditioning, booster, condensate and other services are these close-coupled centrifugal pumps, Figures 3642 and 3643. Of single stage, enclosed impeller type, they are reported to offer such advantages as efficiency, simplicity and long service. Since motor and pump are a single complete unit, installation is quick and inexpensive, company points out; you simply bolt the unit down and connect piping and power. And the pump's compactness lets it fit in small spaces.

It is noted that once the pump is primed, the mechanical seal is protected from running dry. Discharge may be located in any one of eight positions, with drain, vent and priming openings provided. Because the casing is vertically split, maintenance can be accomplished without disturbing piping connections. Figure 3642 comes in 1- and 1¼-in. sizes with motors from ¼ to 2 hp, capacities to 100 gpm. Figure 3543 comes in 1½- and 2½-in. sizes, with 3- to 7½-hp motors, capacities to 350 gpm. Specifications on these two pumps are provided in Bulletin 624. Goulds Pumps, Inc.

14—RUBBER COMPOUND with non-sticking characteristic

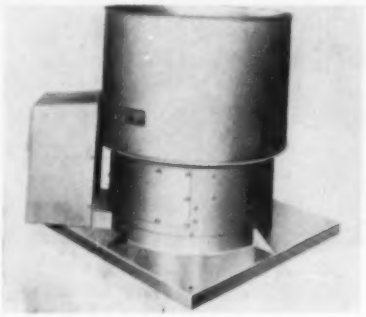
Outstanding non-sticking properties claimed for Compound 1318 suggest its use for valve seat and other applications. Manufacturer says this material gives quick break-away without lubrication and has excellent bonding-to-metal properties. Recommended temperature range for Compound 1318 is from −40 to 300 F. Goshen Rubber Co., Inc.

15—FUME DUCTS, HOODS OF corrosion resistant plastic

Fabricated of a thermo-setting plastic material which is combined with glass or other synthetic fibers, Duracor Ducts and Hoods can be produced to virtually any required shape, it is announced. The combination of chemical resistance, light weight, strength, workability and attractive appearance is reported to make Duracor an ideal material for chemical fume ducts. In addition, hoods and ducts fabricated by manufacturer from this material are claimed to provide a high degree of resistance to acids, including hydrofluoric, as well as alkalis and solvents. Physical properties of Duracor materials range from 11,000 to 15,000 psi for tensile strength; flexural strength ranges from 22,000 to 30,000 per sq inch depending on desired thickness. It is pointed out that because of lightweight and easy handling these ducts and hoods require only minimum installation time and overhead ducting can be supported simply because of the low weight factor. The Ceilcote Co., Inc.

16—ROOF VENTILATORS come in four models

Propeller type power roof ventilators with certified ratings are announced as featuring a redesigned fan wheel that produces optimum efficiency when operating within the type of enclosure



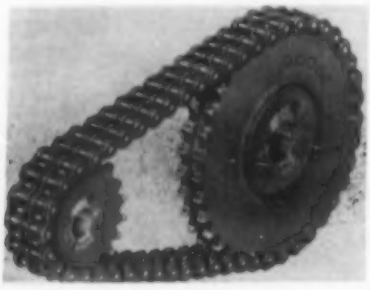
formed by a power roof ventilator housing. The new line includes four models: upblast type exhaust (pictured); hood type exhaust ventilator; hood type supply ventilator; and air intake hood. All are of heavy-gage welded steel construction, with surfaces phosphatized for rust resistance and finished in baked enamel. Each model is provided with a flanged base for easy curb mounting. Hood types are described as fully weatherproof. American Blower Corp.

17—RE-RATED MOTORS offer several improvements

Six advantages are announced for this company's Series 254U Motors, re-rated to conform with new NEMA requirements. Foremost of these is the elimination of "hot spots" through straight-through dual sweep ventilation. Tandem fans, one pushing and one pulling, produce a washing action over the field coil ends to assure lower temperatures. A second feature is the use of Mylar, laminated to rag paper, as slot cell insulation. Easy bearing inspection is provided for by means of removable cover plates on each end head to permit inspection without dismantling the motor. Installation and maintenance

12—DOUBLE STRAND CHAIN SPROCKETS are easily installed

New additions to this manufacturer's Taper-Lock line are double strand roller chain sprockets requiring no reboring or other machining for installation on shafts. Available in pitch sizes from ½ to 1 in., the new double strand sprockets are designed to meet the need for greater capacity roller chain drives with easy-on, easy-off features of Taper-Lock. They may be used with company's double strand chain or other standard precision chains conforming to ASA specification.



Several advantages are announced for these sprockets. Company points out that you can take them (together with bushings of desired shaft size) directly off the shelves of distributors and mount them quickly and securely without reboring, key seating, or set screw machining — regardless of whether the shaft is turned and ground or cold rolled, standard or normally undersized. Installed cost of Taper-Lock Sprockets is reported usually less than that of sprockets which have to be bored to size. Another economy feature noted is that the bushing can be used over and over again; and if the sprocket becomes worn, only the tooth part need be replaced. A Taper-Lock Sprocket occupies no more space on the shaft than other sprockets and its flush design (even screws are recessed) contributes to safety, and neat appearance. Dodge Mfg. Corp.

Now — A Revolutionary NEW Steam Trap!

INSTALL IT — FORGET IT!

ACTUAL SIZE

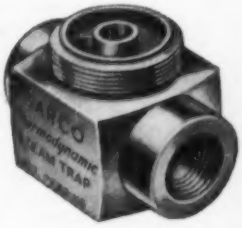
SO RUGGED **SO SIMPLE**

this steam trap practically eliminates maintenance

1. A CAP

2. A DISC

3. A BODY



That's all!

Major advance in trap design!

Imagine a steam trap machined from a solid block of stainless steel. A trap with only 3 parts...cap, disc and body...and not even a valve-closing mechanism — the kinetic energy of steam closes the valve and ONLY the TD uses this new operating principle.

That's the revolutionary new Sarco type TD. It has only one moving part...a hardened SOLID stainless steel disc. And it is not affected by superheat, water-hammer, corrosive condensate. That's why we can say INSTALL IT—FORGET IT!

Use the SAME trap for 10-600 psi...for light or heavy loads ...without seat or valve change or other adjustments. Closes tight on no load—no steam waste.

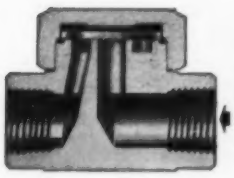
Ask for a 60 day trial installation of Sarco TD trap and strainer...write for bulletin 257. Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.

3150-B

SARCO

Only Sarco Makes All 5 Types

That's why Sarco can give impartial advice on proper steam trap selection.



SIMPLICITY ITSELF!

No valve-closing mechanisms to wear or stick. No critical clearances to choke. No gaskets to leak. Only moving part a SOLID stainless steel disc.

Thermodynamic Steam Traps

Thermostatic Steam Traps

Float Thermostatic Steam Traps

Liquid Expansion Steam Traps

Camlift Bucket Steam Traps

For more data circle 537 on Post Card

are simplified through permanently-numbered leads. Full-height end-head protection is provided by one-piece, shrouded end heads, and internal baffles complete the splash-proof construction. Also, factory-installed end-head screens are included at no extra cost, says manufacturer, and even with the screens in place you get a 40 C rise motor. Robbins & Myers, Inc.

18—SOOT BLOWER designed for the extra wide furnaces

The Vulcan T-30 is a long retractable soot blower for wide furnaces. It is built for traverse travels in excess of 36 ft. Manufacturer says it is well suited for outdoor installations in northern cli-

mates, and it can use either air or steam, with nozzle pressures from 50 to 425 psig, as the blowing medium without change in equipment. Dynamic balancing of nozzles serves to prevent vibration and whip of the lance during operation.

The soot blower uses two electric motors, one to extend and retract the lance, and one to rotate it for a clean sweep of the tubes. Different speeds are available for both movements. Rotation of lance is always in the same direction. This, together with a change in retraction path, forms an infinite number of double-helix patterns of the blowing medium on repeated cycles to clean surfaces uniformly and minimize danger of tube cutting. The alloy lance is reported to have exceptional strength at high temperatures. Motors are located away from hot furnace gases. A steel scraper plate, installed adjacent to boiler wall, removes hard, crusty particles of soot and slag while the lance is retracting. Copes-Vulcan Div., Blaw-Knox Co.

19—AIR RELEASE VALVES have bronze valve and seat

These heavy duty air release valves (air traps or air vents) are automatic and continuous in operation, manufacturer states, and release air as fast as it accumulates. They are normally installed at high points of a piping system where air pockets naturally form. Of heavy duty construction, the valves have body and head of cast iron metal. Inside is a copper float which actuates a bronze valve and seat.

In operation, air enters the bottom inlet of the air release valve which is connected to the piping system. This air bypasses the valve and seat escaping to the atmosphere through the vent at the top of valve. When the system contains no air, the liquid passes through the inlet, raises the float which, in turn, actuates a valve through a lever. This closes the valve against the seat at vent opening. Additional accumulation of air or gas in the system lowers the liquid level, causes the float to drop, opening the valve, and releasing the air or gas.

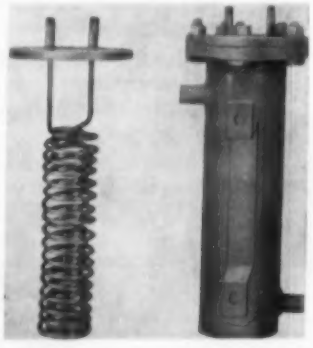
Applications of these valves include water mains, oil lines, brine lines, water filters to release air restricting the flow of the liquid; hot water heating systems; chilled water conditioning systems where air retards circulation and cuts cooling. The valves come in three types: Type No. 70 in ½-in. size for pressures to 125 psi; Type 72, ½- and ¾-in. sizes, for 250 psi; Type 73, 1- to 1½-in. sizes, for 250 psi. Complete information is in Bulletin 856. The V. D. Anderson Co.

20—PACKAGE GENERATORS for forced circulation systems

Designed specifically for forced circulation, hot water systems, these package generators have outputs ranging from 670,000 to 6,700,000 Btu, and from 4,467 to 44,667 gross EDR. They are made to handle varying requirements of large or small hot water heating systems, singly or in a battery, and to take recirculated water from return lines with wide temperature differentials. The method uses the entire firetube heating surface by forming flame in a cyclonic shape and motion along the complete furnace length. The first pass through firetube delivers 65 to 70 per cent of the fuel value, while single pass of return tubes uses residual gas heat for additional 15 to 20 per cent efficiency. In this operation, the hottest water is delivered first. With just one return of tubes, no distortion takes place in the natural convection current. Water nearest firetube becomes heated and rises while cooler water, recirculated from the heating system, is drawn to firetube wall, therefore no heat is wasted. Each model is adaptable to burning oil, gas, or a combination. Modulation controls on most models automatically regulate amount of fuel to maintain desired constant temperature Five simple connections — for fuel, water, electricity, hot water outlet and flue — make installation easy. Cyclotherm Div., National-U. S. Radiator Corp.

21—SAMPLING UNIT for boiler water analysis

Designed to prevent "flashing" when taking boiler water samples for water treatment analysis, this sampler is an-



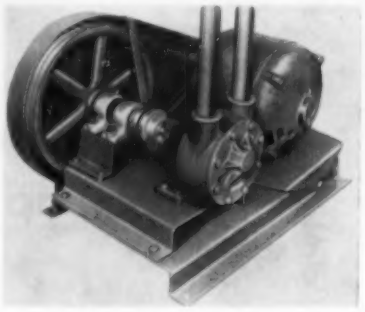
nounced as suitable for boiler blowdown to 900 psi and 750 F. Its mounting bracket provides for installation on any control panel, and it may be installed in any position. The unit weighs 40 lb, is 4½ in. OD, 16 in. long, with cooling water connections ½ in. IPS. Sample inlet and outlet are ¼ in IPS. Standard cooling coil contains 30 ft of copper tubing. Rempe Co.

22—GEAR MOTOR provides remote, automatic control

The Shaftrol is a shaft mounted gear motor designed to provide remote and automatic control for variable speed drives, valves, pumps, feeders and other machines. It mounts on shafts from ¼ to ⅞ in. in diameter, company says, and is light and compact, with both housing and cover made of aluminum. It is furnished with a torque arm or torque plate with resilient mounting to absorb any runout that may be present in shaft to be controlled. When used on rising stem valves torque plate is equipped with linear bushings to allow axial movement. Unit can be mounted horizontally or vertically with the shaft up or down. Speeds from ½ rpm to several hundred rpm can be had, and torques from inch-ounces to several hundred inch-pounds. The Jordan Co.

23—PUMP UNITS for heavy fuel oils in burner service

Type SU Pump Units are designed principally for handling heavy fuel oils in industrial and commercial oil burners.



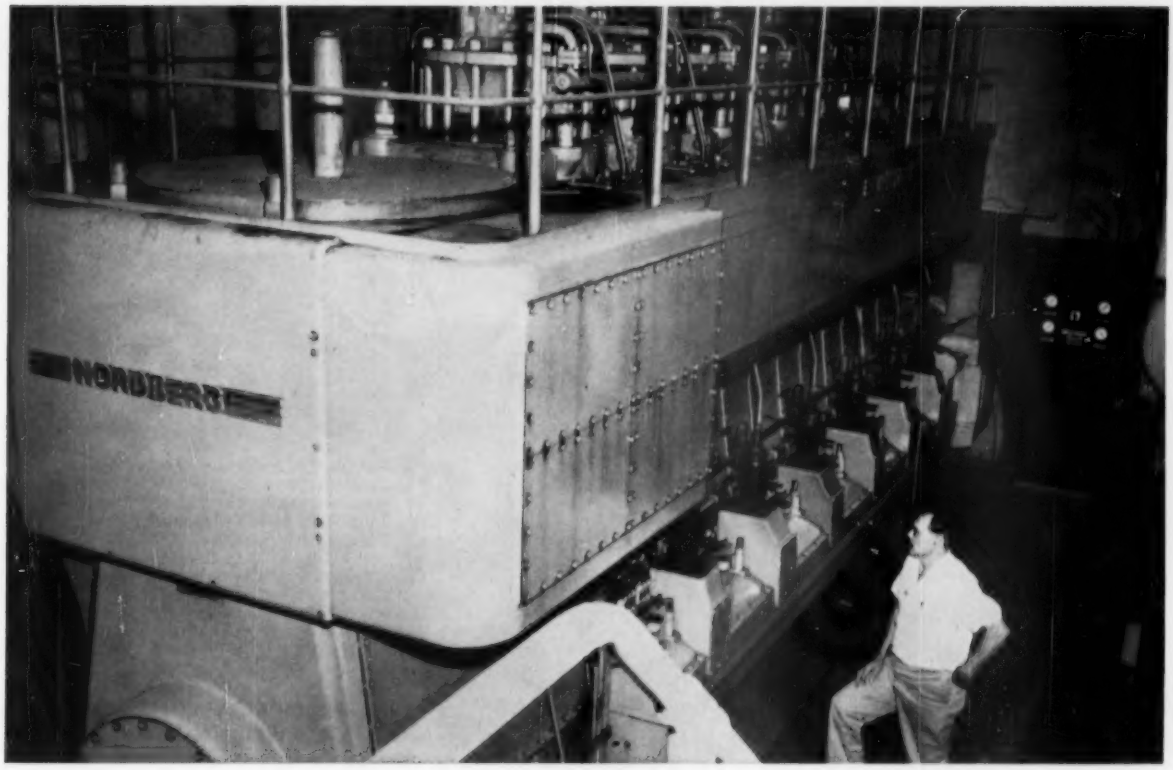
They may also be used for the movement of any non-corrosive, highly viscous liquid with lubricating qualities. Company says they have a simplified design in which lighter weight construction is achieved without sacrifice of durability. Units are provided for two or four V-belt drives, for pressures to 300 psi, and in capacities to 2030 gph. Tuthill Pump Co.

24—SERVICE REGULATOR offers increased relief capacity

Almost double the relief capacity of any previous service regulator is claimed for the Model 143. This internal-relief service unit is available with die-cast aluminum upper and lower diaphragm cases, and reported to combine light weight with advantages of 360-deg swivel design and several safety and operational features incorporated for the first time in a service regulator. Its relief capacity is approximately 3000 cu ft per hour with outlet pressures of 1 lb or less. Three design features contribute to increased capacity: direct upward venting through the spring housing when internal relief valve is open; spring housing affording large vent area with no small restricting orifices to retard flow; and large passages on either side of the I-beam construction at the regulator throat to allow any pressure build-up to be quickly transmitted to the lower diaphragm case.

The 360-deg swivel feature enables the regulator to vent downward so that

Look to COOK for Better Rings!



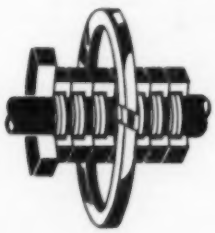
Cook rings save $18 per day on one 2400-hp Diesel engine

WHEN a switch was made to Cook Piston Rings, Key West Electric's No. 12 Diesel showed a saving of $41,670, for 55,542 operating hours — *an average saving of $18 per day!*

There are good, built-into-the-ring reasons why a switch to Cook almost inevitably leads to more efficient performance, more dollar savings. Cook rings are re-turned as a final manufacturing process . . . they're light-tight, conform perfectly to the cylinder wall. This prevents scuffing and power-stealing blow-by. Also, Cook rings are tensioned by a unique, gentle "squeezing" process. Result: constant, uniform tension that *never* wears out.

Get *all* the facts on this $41,670 saving.

Get complete operating data showing exactly how Cook piston rings compared dollar-for-dollar with "X" brand rings. Write for the Key West Electric Story, C. Lee Cook Company, 996 South 8th Street, Louisville 3, Kentucky.



C. LEE COOK COMPANY

Rings and Packings Since 1888

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control batteries are built for

25 years of

"packaged power"

At Weyerhaeuser Timber Company, switchgear control batteries in Everett, Wash., sulphite mill are C & D PlastiCal® —the batteries built for control . . . and to last 25 years.

. . . they're C&D PLASTICAL®

Not just "batteries"! These are *engineered* C & D PlastiCal® (lead-calcium) control batteries—batteries specifically designed for switchgear, control, and auxiliary power service —batteries built to deliver high, steady output with only minimum maintenance *for the next quarter-century!*

Weyerhaeuser Timber Co., big suppliers of woodpulp to the paper and allied industries, wanted more than just batteries. Their choice: C & D PlastiCal® —the control batteries with the "more battery for the money advantages."

See why

For details, send for Bulletin CP-536. Find out about the battery of tomorrow—today!

C&D BATTERIES, INC.

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Since 1906

Sales and service offices in principal cities from coast to coast

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no condensate can collect in — or rain enter — the vent on outside sets. This "umbrella" feature also serves to minimize possibility of the vent freezing over. Bronze bushing and valve stem are incorporated to eliminate corrosion and possibility of galling. Meter and Valve Div., Rockwell Mfg. Co.

25—RACEWAY SYSTEM is installed flush with floor

Primarily for modernizing existing buildings, Flushduct is installed by trenching the existing floor so the ducts can be flush with the surface of the floor. Top

surface materials are then laid directly over the duct system. Like company's standard Nepcoduct, the ducts come in 10-ft lengths with outlets spaced every 24 in. and each outlet closed with a brass cover plate. Flushduct is available in single-, two-, or three-duct systems; the latter two are welded together. Generally, standard Nepcoduct elbows and fittings comprise system components. National Electric Products Corp.

26—COMPACT SWITCH for use in limited access areas

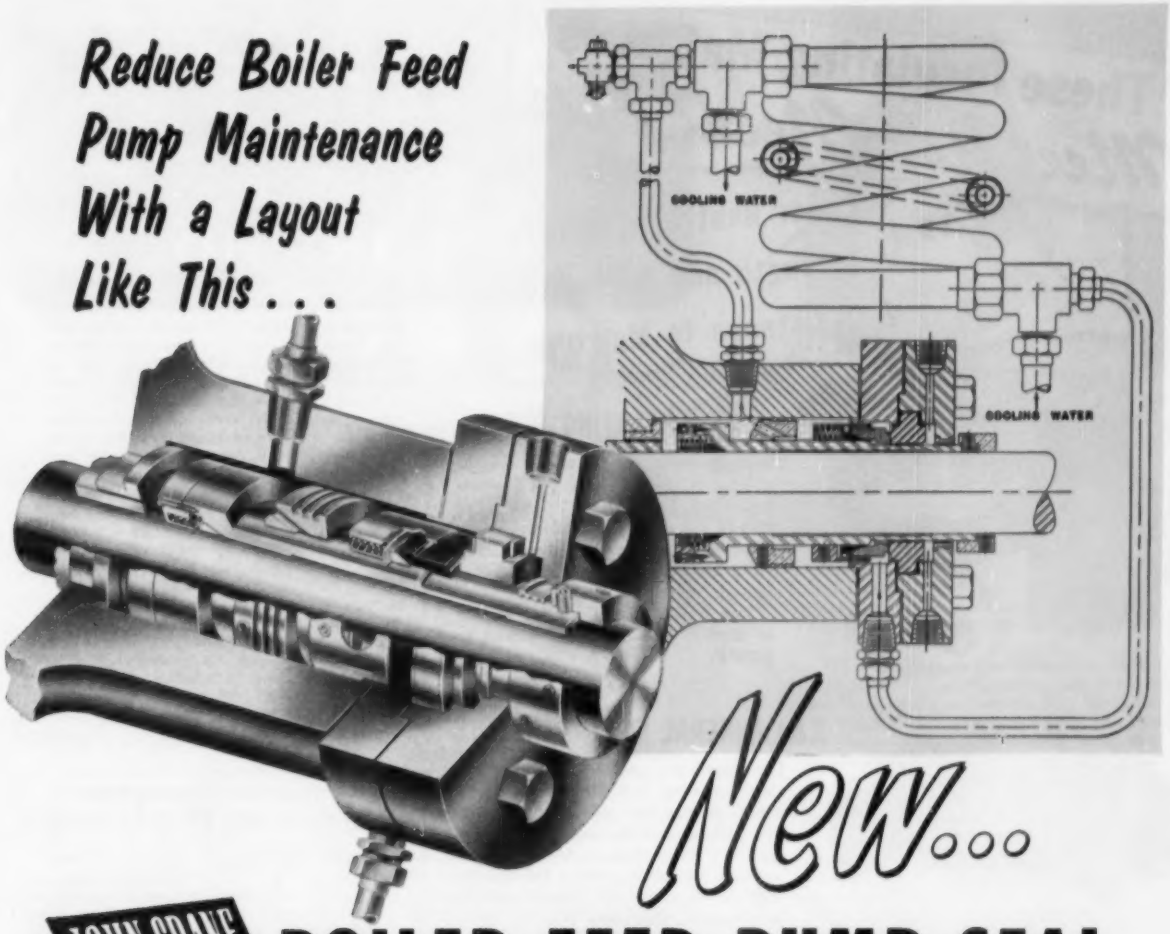
Here's a switch that can be installed in hard to reach areas and actuated by screwdriver. Designated the 1RA1, this compact switch is reported especially handy for use in out-of-the-way places or where a switch needs to be operated only occasionally, such as when testing circuits. It can be installed deep inside equipment and operated by inserting a long screwdriver through an access hole. The switch is a subminiature single-pole double-throw assembly. It has a slotted actuator head, with 90 deg-rotation that shows switch position. Its bushing permits one-hole mounting in panels up to 3/32-in. thick. Manufacturer states that this switch is UL listed for 5 amp, 125 or 250 v a-c, or 3 amp inductive at 30 v d-c. Micro Switch, Div., Minneapolis-Honeywell Regulator Co.

Reader Service Cards on pages 131–132 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

27—UP-FLOW VENT protects underground storage tanks

The No. 45 Up-Flow Air Vent is designed to eliminate dangers of accumulating vapors in under-ground storage tanks by permitting the vapor to escape easily in an upward direction. According to manufacturer, the oversize area of the No. 45 Air Vent lets vapors escape

Reduce Boiler Feed Pump Maintenance With a Layout Like This . . .



New . . .

JOHN CRANE BOILER FEED PUMP SEAL

You get cost savings in four ways:

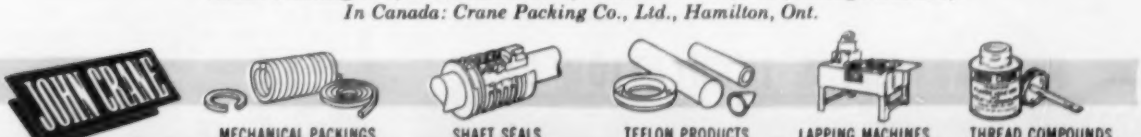
1. Replacement costs and "down time" are reduced. Service life is much longer than with other sealing methods.
2. Maintenance expenses are reduced. Once installed, the seal needs no further attention. Costly replacement of expensive sleeves is eliminated.
3. Long seal life—special closed circulating system provides cooling water in sealing chamber for best seal performance.
4. There is no leakage. Loss of valuable feed water is eliminated.

You get 4-way job-engineered performance:

1. "John Crane" engineers the seal to your operation. This includes adaption to your pump design and piping arrangement.
2. You are furnished with carefully drawn up plans. All necessary recommendations are supplied. Heat exchanger size is specified.
3. Package design provides easy installation and removal of seal without major pump dismantling—can be installed as readily in existing equipment as in new pumps.
4. "John Crane's" world-wide service organization and experienced engineering staff stand behind your installation.

Now is the time to investigate this new boiler feed pump seal. Write for new illustrated technical bulletin.

Crane Packing Co., 6429 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.



CRANE PACKING COMPANY

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These Insulating Materials Meet Your Needs Best

for ✓ Lower Heat Conductivity
✓ Strength and Durability
✓ Resistance to Moisture

R & I INSULATING BLOCK

High in structural strength, low in thermal conductivity, R & I Insulating Block lasts longer; light, firm, easy to cut or saw and install; is unaffected by steam or water; resists vibration, compression, abrasion and impact.

Two types: #12 Block for service to 1200°F. #18 Block for service to 1800°F.

R & I MINERAL FIBER BLANKETS

Laminated for greater insulating efficiency, density and strength for use to 900°F. Strong and durable; maintain full body and thickness under all normal service conditions. Available with various reinforcing metal fabrics and lath in standard and special sizes in any blanket thickness from 1" to 6".

STIC-TITE PLASTIC INSULATION

The best all-white, all-purpose plastic insulation for easy application directly over metal surfaces, or over insulating block or blankets. Sticks tight permanently even under severe vibration or abrasion.

Stic-Tite dries with practically no shrinkage. Has highest insulating efficiency of all insulating cements up to 1800°F. Economical—100 lbs. cover 45 sq. ft., 1" thick. Can be removed, crushed, mixed with water and reused.

For one-coat plastic finish insulation—use Super Finish Stic-Tite, a finely ground, pure white, high quality cement. Finishes smooth; no roughing coat needed. 100 lbs. covers about 80 sq. ft. ½" thick.

To help you, this new R & I bulletin on R & I Insulating Materials provides complete data on properties, thermal and physical characteristics, and how and where to use data. Write for a copy today.

REFRACTORY & INSULATION CORP.

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

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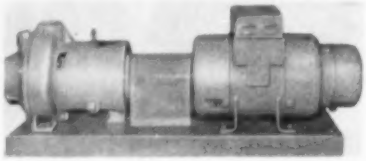
rapidly without any restriction to flow, even under "tight-fill" service practice. Simple three-piece construction includes hood, screen and body, assembled with single center screw. With the exception of the removable brass screen, all parts are made of aluminum. The design features a three-spout "cone-shaped" hood which provides an escape route for drain water. The vent comes in 1½- and 2-in. sizes. Universal Valve Co.

28—CIRCUIT BREAKER is high-speed, 5 kv magnetic type

For use on 4.16-kv distribution systems, the Type 50-DHHS is announced as a 600-amp breaker with an interrupting capacity of 30,000 amp (40,000 momentary), which can be applied where conventional 150-mva circuit breakers are now used. The fast interrupting time is expected to effect considerable reduction in wire damage in clearing faults on overhead lines. Moving parts are made of lightweight, high-strength materials, it is noted, and roller bearings are used to reduce friction. According to company, these mechanical refinements combined with a high-speed trip device, permit a contact parting time of only ¾ cycle after energizing the trip coil. Closing current for the new breaker is approximately 90 amp and the trip current is 25 amp, it is noted, and standard overcurrent relays or high-speed relays can be used to trip the breaker. Westinghouse Electric Corp.

29—TURBO-ALTERNATOR is single-unit 60-cycle model

Sixty-cycle alternating current can be produced for regular or stand-by requirements by this turbo-alternator combining mechanical drive turbine,

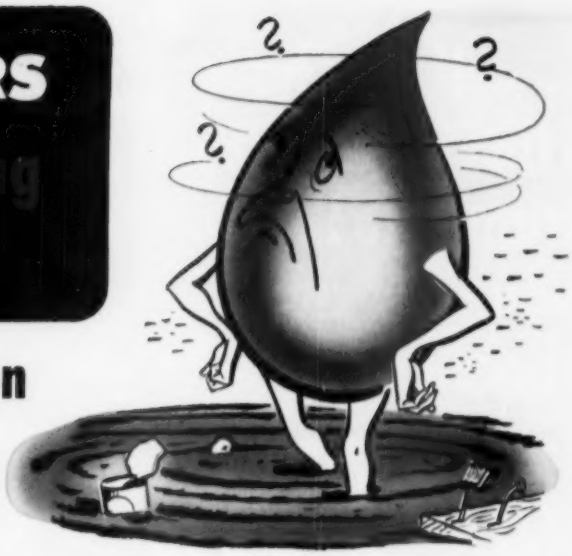


generator, exciter and voltage regulator in a single unit, it is announced. For places where utility failure might prove disastrous, or for installations where utility service is not available, this unit is designed to provide a constant voltage that keeps lights bright and motors at peak operation. It is manufactured in 3.75- to 25-kva capacities, single or three phase, and 120/208. 240 or 480 v. The unit can be furnished drip-proof, splash-proof and explosion-resistant. The Pyle-National Co.

30—TRAP discharges condensate from compressed air and gas

System-power action is featured by the Mag-Pneu-Power Trap, which discharges condensate from compressed air or gas lines by a combination of magnetic, pneumatic and automatic action. As the condensate in the trap rises, the float does not rise, company explains, but is held in place by the magnet on the pivot arm. When the force build-up of the condensate working on the float overcomes the magnetic attraction, the float "snaps" open the pilot valve. Air enters the pilot valve, flows down the

ALLIS-CHALMERS
Water Conditioning
ON THE JOB



Reporter finds solution to wide range of water problems

•Raw water is seldom suitable to meet specific requirements of the job. It usually needs some type of conditioning — best determined by a specialist. Here are typical examples of Allis-Chalmers water conditioning experience, equipment and chemicals in use.

Saved $22,000 First Year

Kansas—A chemical company plagued by high steam costs. Their boiler make-up water contained a high solids concentration, requiring a high blowdown rate.

After careful analysis of their problems, an Allis-Chalmers water conditioning engineer recommended Allis-Chalmers Anti-Foam. Use of this chemical resulted in increasing the solids concentration of the boiler water without carry-over. This, in turn, reduced the percentage of blowdown required.

Using A-C Anti-Foam, the company conservatively estimated first year savings of $22,000 in heat, water and chemicals.

* * *

Replacement of Condensate Return Lines Reduced to Practically Zero

Wisconsin—Here in one of the largest malt producing mills, several million pounds of steam are used daily for drying malt.

A special crew used to work all day every day doing nothing but replacing corroded condensate return lines. This, of course, was extremely costly.

Seven years ago, Allis-Chalmers water conditioning engineers were called in. Use of Allis-Chalmers No. 160 return line corrosion inhibitor was suggested.

Piping failures were reduced to the point where they only occur occasionally, and the maintenance crew has been assigned to other duties.

The Customer Is Always Right . . . Well, Most of the Time

East Coast — This plant had been using internal treatment of its boiler water. Chemical costs seemed excessive to management. After analyzing their own situation, they requested bids on a deionizer for treating makeup.

Instead of merely submitting a bid on the equipment specified, Allis-Chalmers engineers analyzed the water and the plant problem. This analysis showed that plant needs were such that a deionizer wasn't needed.

All that was needed was a de-alkalizer. Result: a savings of thousands of dollars.

* * *

The Case of the Dirty Dishes . . . or Don't Blame the Poor Dishwasher

Midwest — A harried plant cafeteria manager placed a frantic call to Allis-Chalmers water conditioning experts. Something was wrong. Glasses were spotty and plates had to be individually wiped off before they could be used. The grumbles were growing in the dining room . . . costs rising in the kitchen. His brand new $30,000 dishwasher wasn't getting the dishes clean, and the supplier of the dishwashing machine said the trouble was caused by the water.

The only trouble with that theory was that he had just installed a water softener the year before. The Allis-Chalmers water conditioning engineer examined the dishes coming out of the water and then asked to see the water softener. The problem was obviously hard water. The unit seemed to be in good working order and the tag indicated the softener had been recharged the previous day.

The maintenance man was called and asked to recharge the softener while an A-C engineer stood by. He went through all the steps—all but one, that is. He failed to close the bypass valve above the softener and practically none of the water went through the softener. It was then learned the operator was new and had not been properly trained.

Needless to say, the maintenance man is now an expert at operating the system, and everyone is pleased with the sparkling dishes.

Moral: A-C engineer's service covers the water front.

Expert Saves Steam for Drop Forge User

North Central — An Allis-Chalmers water conditioning engineer was called in by a manufacturer to supply water conditioning for makeup water. In checking the plant, here's what he found:

A large number of steam-operated drop forges are used by this company. The steam picked up oil from the pistons of the forge and was too contaminated for further use. It was dumped to waste.

He recommended installation of condensate oil removal filters. This was done and today practically all condensate is recovered. Makeup and water conditioning requirements are greatly reduced.

Problems Solved

For an answer to your industrial water problem, call the A-C office nearest you or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

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stem, and up under the piston, forcing piston assembly upward. As this occurs, it opens the main discharge valve. Condensate is forced into this valve by the system pressure, and out into the discharge outlet.

When sufficient condensate has been discharged, the float drops and the magnetic attraction to the float arm causes the snap closing of the pilot valve. When the pilot valve snaps shut, the air supply to the piston is cut off. Air in the piston chamber bleeds through a minute orifice, the piston returns to its original position, closing the main discharge valve. The piston mechanism is sealed off from the condensate to prevent damage or clogging. Pressure range of the trap is from 10 to 200 psig. Details are in Bulletin 501. Hankinson Corp.

31—RACEWAY facilitates wiring with solderless connectors

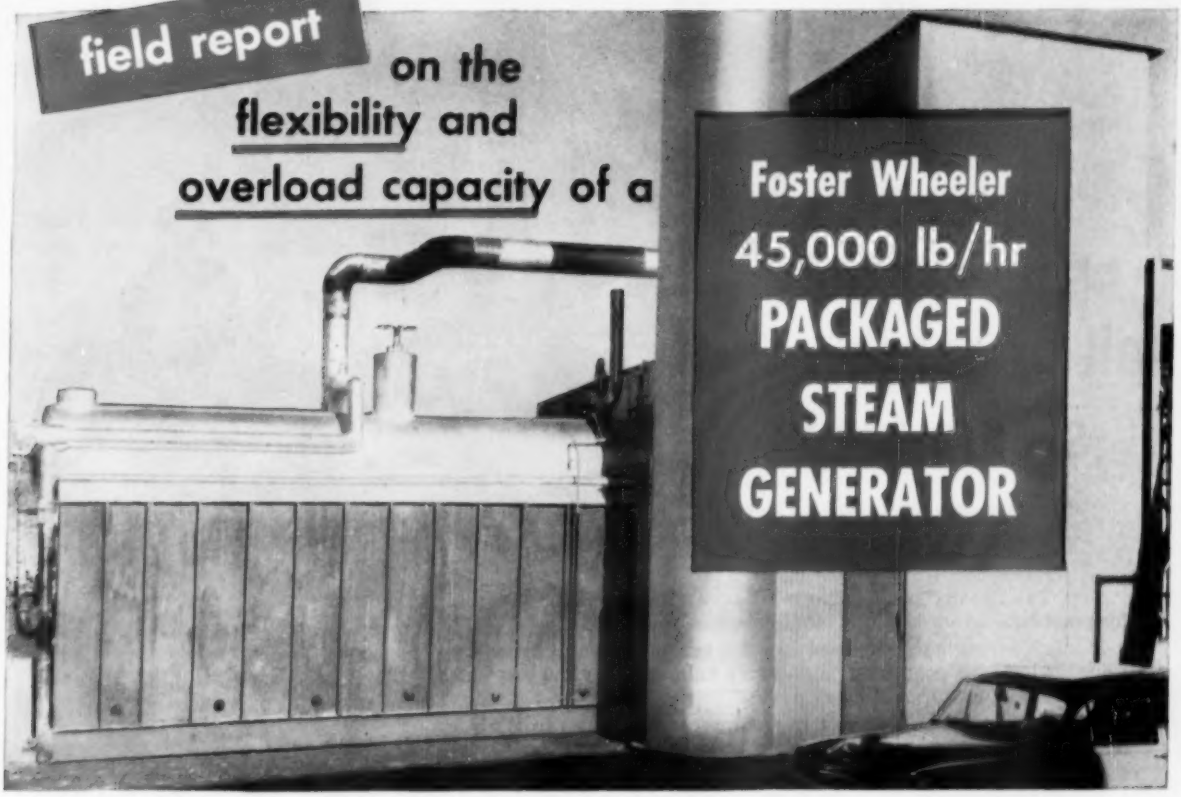
Improved Panel Chanel Raceways have been developed to permit quick wiring of electrical and electronic equipment with pre-cut wires already equipped with solderless connectors. According to manufacturer, Panel Chanel Raceways eliminate wire bundling and lacing, reduce

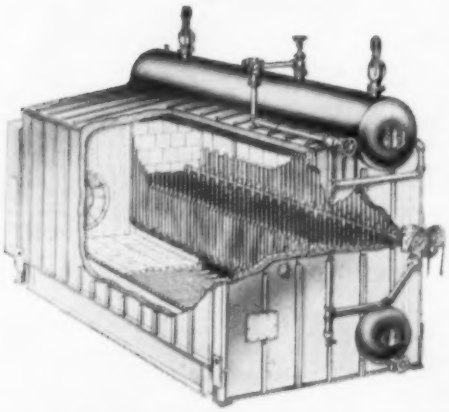
work and copper loss in any wire grouping operation. The new design provides slots, instead of holes. Wires with terminals can be readily passed through the slots, it is noted, yet there is no sacrifice in structural strength of raceway. Arrangement of wire slots permits wiring to leave Panel Chanel on same plane as destination terminal. Panel Chanel has phenolic construction claimed not affected by normal high temperatures encountered in control panels. Sizes from 1 by 1 in. to 4 by 4 in. are available. Bulletin S-301 gives data. Stahlin Brothers, Inc.

32—HIGH-VOLTAGE STARTER incorporates contactor

In these NEMA Class E-1 high-voltage air-break starters, a contactor has replaced current-limiting fuses to provide interrupting capacity. According to company, when the need for increased interrupting capacity arises, the starter may be easily and inexpensively converted to give maximum interrupting capacity of 150 mva at 2300 v, 250 mva at 4000 or 4600 v. The line can be applied in any plant where a high-voltage starter is needed and available power supply is limited to 50 mva or less. For use on utilization voltages of 2300 to 4600 v, starter incorporates the best features of company's Limitamp controllers. It is entirely front-connected, requires a minimum amount of floor space (30 in. deep by 38 in. wide by 90 in. high), has a roll-out contactor, gang-operated disconnect switch, maximum rating of approximately 3000 hp at 4600 v. General Electric Co.

field report on the flexibility and overload capacity of a Foster Wheeler 45,000 lb/hr PACKAGED STEAM GENERATOR





Cutaway drawing of FW Packaged Steam Generator of the type shown installed above at a large New England chemical plant. Except for the firing front, the entire unit is located out of doors. The performance tests mentioned here were made in December, under typical New England weather conditions.

FOSTER WHEELER engineers have conducted extensive performance tests on a 45,000 lb/hr oil-fired Packaged Steam Generator installed at a large New England chemical plant.

During a 30-day period, the unit was operated at 42,500 lb/hr on a 24-hour basis, delivering over 1,000,000 lb of steam per day. It was also operated at 46,500 lb/hr over an 8 hr period.

Efficiency at design load of 45,000 lb/hr exceeded contract requirements of 83.2%. During performance tests the boiler was operated in excess of 51,000 lb/hr at an efficiency of 82%.

Although purchased as a base load unit, tests were also conducted to determine its flexibility. Rapid load swings from 10,000 to 51,000 lb/hr were set up while on automatic control. The boiler was able to swing from one extreme to the other in considerably less than 60 seconds.

This very satisfactory performance stems from the conservative FW design and generous water storage capacity which are important features of the entire standard line. Available in rated capacities from 10,000 to 50,000 lb/hr, with wide choice of burners and controls. For complete information, send for Bulletin No. PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

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Revolutionary when introduced 20 years ago, the *Yarway Impulse* principle has been proved by more than a million in service everywhere, is still gaining new friends every day.

SERIES 60—for *normal steam trap requirements;* pressures to 400 psi, temperatures to 450° F. Stainless steel body and working parts. Six sizes, ½" to 2".

NO. 20-A—available in ½" size only— similar to ½" #60, but with low capacity—designed especially for *light condensate loads.*

SERIES 120—same as Series 60 but for higher pressures and temperatures (600 psi, 750° F). Featuring all-stainless steel construction. Six sizes, ½" to 2".

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INTEGRAL STRAINER TRAPS—for marine use and for high pressure trapping service in steam power plants with pressures up to 2500 psi. Six sizes, ½" to 2"; flanged and socket-welding ends.

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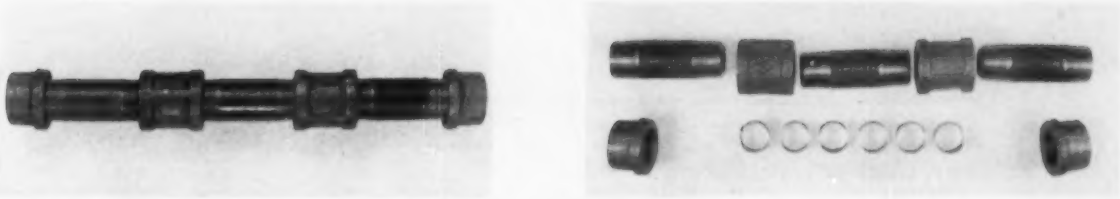


Fig. 1 (Left). Assembly of the Bureau of Mines corrosion tester. Fig. 2 (Right). Component parts of tester: 6 rings, each ½ in. long, go in the 3-in. center nipple

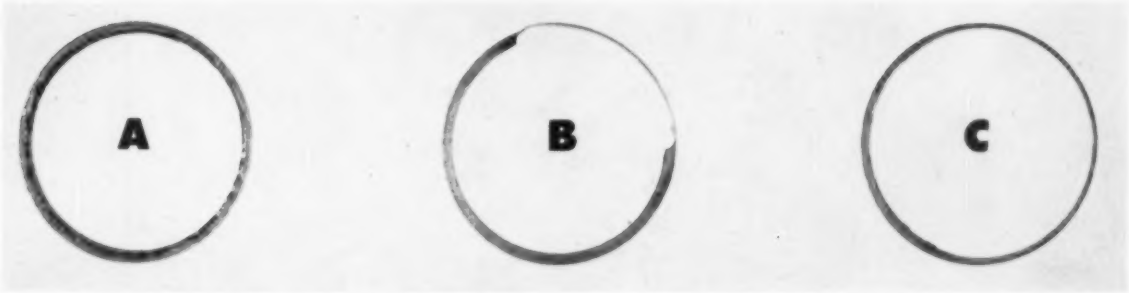


Fig. 3. Characteristic corrosion patterns shown by rings exposed in tester as shown in Figs. 1 and 2: A—pitting; B—channeling; C—non-concentric thinning

This Tester Shows Condensate Corrosion Patterns

AREA HEATING plants operated by Federal agencies throughout the country frequently have several miles of condensate-return piping. In some instances serious corrosion has caused expensive losses of valves and piping. One of the defense agencies evaluated its maintenance costs from questionnaires and estimated that over $2,500,000 was spent during the first six months of 1955 for replacing and repairing such systems in its installations in the United States.

Treatment with neutralizing amines was found to be a satisfactory method of controlling corrosion arising from high carbonic acid concentrations in steam condensate, and other methods were also developed using different chemicals. However, all these methods were quite expensive, and to use them at all plants, whether or not corrosion were present, would be very costly.

Basing recommendations for treatment on local reports of trouble was also unsatisfactory, because some operators call attention to replacement of individual nipples in a system, while others regard severe corrosion as normal. Furthermore, when treatment is begun after maintenance costs have become high, the system will usually be seriously deteriorated before corrosion is controlled.

Thus some kind of screening test was needed to determine in which plants chemical treatment would be justifiable economically. In ASME Paper 56-A-179, A. A. Berk, chief of the Industrial Water Laboratory of the U. S. Bureau of Mines, describes the simple and efficient condensate-corrosion tester they developed for this purpose.

The tester consists of six rings or shells fitted into a specially machined pipe nipple, which is then installed in the return-line under test. Average weight loss of the rings during the exposure of the tester is evaluated in terms of an average corrosion index; the resistance of the tester surface to acid spot tests provides a measure of the effectiveness of the corrosion products toward stifling further corrosion and the surface of the cleaned rings shows the corrosion pattern, indicating the factors responsible for the corrosion.

Figures 1 and 2 show views of the tester, and Fig. 3 shows three characteristic corrosion patterns: — pitting, channeling, and non-concentric thinning.

The advantage of this tester over other types using test pieces in the center of the pipe is that the rings are subject to the same corrosive effect as the pipe itself, whereas with test pieces in the center of the pipe, flow and corrosion conditions at the center might be different from those at the pipe surface. Also, if corrosion is heavier at one particular point around the circumference of the pipe, the rings will show it, whereas the test pieces in the center of the flow may not.

When the tester evaluation shows a corrosion problem, the operating practices at the plant are reviewed. Frequently, control is effected through decreasing the carbonate content of the feedwater. For example, it is often possible to reduce losses of steam and condensate. In other instances internal boiler-water treatment with soda ash has been replaced by sodium hydroxide. Chemical treatment is prescribed only when it is justifiable economically.

The tester has proved especially valuable for following the improvements resulting from changes in operating practices and, more especially, for determining the extent to which chemical treatment solves the corrosion problem.

More than 1000 testers have been issued to Federal heating plants, and several hundred have been returned for evaluation of the test results. Much has been learned about improving corrosion control practices, and the tester has been found to be a useful tool for an extensive survey at moderate cost.

Fig. 1. When fire is out, the injured treated, how do you determine, beyond reasonable doubt, what caused this tragedy?

How To Investigate a Casualty

By **ROBERT H. EMERICK** *

WHENEVER A TURBINE flies apart, or a corner of the plant burns down, or somebody falls into a tank of chemicals, people in authority always begin asking "How come?" and "Why?"

As engineers, we sooner or later find ourselves appointed to investigate a casualty, and to produce answers to the questions. How well we reach conclusions that are supported by facts beyond a reasonable doubt, determines whether we win credit by our investigation, or something less desirable.

Technique of investigation consists of three phases: establishing facts, questioning witness, and developing a conclusion. The successful application of this technique requires all the thought we can give it. For example, on being appointed as an investigator, our natural urge is to interview witnesses first, but this is properly the second step. Our first step is to establish facts, all the pertinent facts we can, for on these facts we must build our conclusion; neither the words of experts nor the declarations of witnesses are worth a hoot if they are contrary to the facts.

To illustrate how facts are established, suppose we examine the Case of the Exploding Refrigerator. This refrigerator was a large, walk-in unit with an inner freeze room and an outer chill room, and it had the bad luck to be exposed, on one side, to some extreme heat from a nearby fire. Then, ten hours after the fire had been extinguished, and while men were going in and out of the refrigerator, unloading meat, an explosion originated in the freeze compartment which, blowing out through the chill room, killed five men.

An investigating board of three, assigned to explain "How come" and "Why," visited the refrigerator and the contiguous area, and set down these observed facts:

1. Unidentified gas was known to have been present in the area for several hours prior to the explosion;

2. refrigerant was Freon 12, which is non-explosive and non-flammable at any temperature;

3. refrigerant compressors were in fire zone and copper tubing had melted; there was no Freon in the system anywhere;

4. to explode, the gas required ignition, but there was no obvious source of ignition in the freeze room where the full force of the explosion developed;

5. flood lights had been provided outside the refrigerator, using 500-watt lamps, and these lights were still burning after the casualty;

6. there was no evidence of electric short circuits, burned matches, cigarettes, or tobacco in the area;

7. explosive character of the atmosphere in refrigerator continued to build up after the casualty, and two days later showed 100 per cent explosibility on the explosimeter.

In the circumstances, neither investigators nor anyone else cared to spend much time in the refrigerator, but the source and nature of the gas had to be discovered before the investigation could continue. Eventually a hot area was observed on the outside wall of the refrigerator; when drilled into, a block of smoldering insulation, mixed with tar, was discovered. A shot of water stopped the gas production, and by laboratory experiment, the investigators identified the gas as a mixture of carbon monoxide, water vapor, hydrogen, and various hydrocarbons.

* Consulting Engineer

These facts explained how the deadly gas came to be formed within the walls of the refrigerator, but nothing positive could be developed concerning why it became ignited. One possibility lay in the discovery, shortly after the explosion, of charred cork insulation on two lines of refrigerant piping hidden behind a protective barrier of wood. The insulation was still hot, but not actually burning; consequently, it could not be established as fact that a spark in this charred cork had touched off the blast. Reasonable doubt was reinforced by the position of the insulation, for it was on the outside wall of the refrigerator, although not far from the door.

Questioning Witnesses

The second phase of this investigation, questioning the witnesses, demonstrates effectively the art of sifting the true from the false. Questions are best when shaped to draw a *yes* or *no* answer, since this sort of reply can be measured against the facts already established. Here is how it was done with Witness A.

Q: Where were you and what were you doing at the moment of the explosion?

A: I was about 30 ft from the door to the chill room, and just turning to leave the area, when I saw a man light a cigarette.

(*Note: The witness tossed in the cigarette lighting action, because it had been in his mind for some days as a cause of the explosion*)

Q: Can you identify the man who, you say, lighted a cigarette?

A: No.

Q: How far from you was he?

A: About ten feet.

Q: Did you see him take out a cigarette, or strike a match?

A: Well, no.

Q: Then how do you know he was lighting a cigarette?

A: I guess it's because when I saw the little flame, it was high, right up around his hat brim.

Q: Did you ever before see a man light a cigarette at, or above his hat brim?

A: No.

Q: Are you still sure you saw a man light a cigarette?

A: Well, no. Everything happened so fast. It's hard to be sure.

All other witnesses failed to recall any smoking prior to the casualty, consequently the testimony was in accordance with facts, namely that no tobacco, stubs, or matches could be found.

Again, another witness said:

"I saw a blue flame. It was running along the rubber-covered cable to the flood lights. It almost went over my feet."

Q: Did the flame seem to be attached to the cable?

A: No. Sometimes it was up in the air, three or four ft above the cable. I saw it only for a minute, then there was a big bang.

Q: You believe the blue flame ignited the gas?

A: Well, I think it could have.

No facts could be found that supported this testimony. The rubber-covered cable was sound and almost new. An electric potential of 125 v could hardly support a corona, and no breaks appeared in the insulation.

Actually, the propagation of flame in an explosion is instantaneous so far as the human eye is concerned, and these witnesses caught in the middle of it, simply recalled different after-images on their retinas. To one it was the flare of a match, to the other a traveling stream of blue flame. To the investigators these variances from the facts confirmed the facts.

The case of the exploding refrigerator was closed with the conclusion that:

"The source of ignition cannot be determined from the facts available, beyond a reasonable doubt."

The importance of this phrase, *beyond a reasonable doubt*, cannot be over-emphasized. Investigations should be undertaken primarily as fact-establishing assignments, and if the facts indicate that some unlucky person is to blame, proceedings against him will lean heavily on the investigators' conclusions, and these conclusions certainly will discredit the investigators if they are shown to be open to doubt. If we can't offer our findings *beyond a reasonable doubt*, we should say so.

At times, engineers may be asked to investigate casualties for which they are not completely qualified. For example, no sensible electrical engineer should undertake to explain the failure in service of high pressure steam boiler tubes, and he should decline the appointment. This responsibility rests with the appointee rather than with the appointer, for the latter is quite likely to consider an engineer an engineer, and to proceed accordingly.

Danger to an uncertain investigator's reputation is particularly great in important cases that get into court. For example, consider the Case of the Collapsing Oil Tank. This tank was a large new unit in a tank farm, and was under water test immediately before being placed in service. The test had been going on for perhaps 18 hours when a tank gager on top of the tank observed it to be settling slowly on one side. This is not unusual in a new tank, and the gager descended to the ground, and waited there for it to stabilize. However, the tilting continued, then began to accelerate, connecting piping pulled loose, and in a few moments the tank collapsed utterly.

The investigator uncovered these facts:

1: The tank foundation was formed of a soft muck;

2: heavy rain during the night caused the tank bottom to stand in water for several hours;

3: hole approximately 12-ft deep developed under the side of the tank where settling first began.

4: first, or bottom course of sidewall pulled free from the bottom plates to which it was welded.

5: The tank was a total loss except as scrap.

Explosion Theory Ruled Out

The investigating engineer reported that the collapse of the tank was caused, beyond a reasonable doubt, by the failure of an inadequate foundation. This report was completely unsatisfactory to the contractor and to the owner, for it left them with responsibility of poor soil preparation. They endeavored to blame the failure on an explosion of the tank, the explosion resulting from an assumed water hammer that developed when the stop valve on the water line was closed.

This was not a difficult theory to disprove by the investigating engineer in this case, but there have been some court decisions which, by rather thin reasoning, have considered casualties to result from explosions. For instance, in a recent court case, the collapse of an old building was explained by the falling in of the roof, thereby compressing the air within the structure and causing the walls to burst from the air pressure.

Importance of establishing an explosion as the cause of a casualty is that many insurance policies are written to cover loss by explosion; this was so in the case of the collapsing oil tank, and the contractor and owner hoped to collect accordingly.

In important cases, where his findings may not be the end of the assignment, the investigator should consider all possible theories, and compare them with the observed facts. Forethought of this kind can save some extremely embarrassing mo-

Fig. 2. After this oil tank collapsed under initial water test, opinion was divided. Engineers had to dig up *facts*

ments later on in the investigation.

Sooner or later, a casualty investigator meets people who, to protect themselves or their friends, tell only a part of what they know. We suspect this when a witness, who is intimately involved, can offer no explanation of what happened, and we feel sure of it also when there is a missing link in the chain of facts.

Best technique in these cases is simply to drop these witnesses, and go beyond them, sometimes to apparently remote areas, for light on the missing information. Here, in the Case of the Burned-out Thrust Bearing, we can see how this technique was applied successfully.

Bearing concerned was on a destroyer, it had been overhauled in a Naval shipyard, and had burned out almost at once on the ship's trial run. Yard personnel responsible for the overhaul were aboard at the time; they had no explanation for what happened.

"Everything seemed to be working fine," they said. "It's just one of those things."

The investigator, knowing that a bearing does not burn out when properly fitted and lubricated, went over the oiling system inch by inch. It was perfect. What then, caused an interruption of the oil supply? No-one knew, no-one could guess.

The Value of Conversation

The investigator began to walk around through the ship's engineering spaces and casually ask some questions. For example:

"Everything run all right? Satisfied with the yard's work?"

Replies consistently were affirmative. Then a machinist's mate said:

"You know, I had a funny thing happen during that trial run. My lube pump No. 2 wouldn't build up pressure for maybe 15 min., then all of a sudden, I had all the oil I wanted."

"Find anything wrong with the pump?"

"Not a thing. Been perfect ever since."

The investigating engineer traced down the piping connected to Lube Oil Pump No. 2; it supplied oil to the shaft on which the thrust bearing had burned out. The investigator next reasoned that a no-pressure condition on the pump indicated an open-end pipe or open valve, somewhere on the system. He examined the bilges for oil. There was none.

Next he began asking the engine room ratings:

"Any of you install a piece of pipe, or valve, or fitting, during the trial run? Anywhere?"

"Nobody had, but one sailor amplified his no.

"I saw some yard men take out a piece of piping."

"Can you show me where they took it out?"

The sailor pointed out a pair of plugged tees, about two ft apart, one in the supply and one in the return piping of the shaft lubrication system.

"I think it was a by-pass of some kind," he said.

That excised by-pass was the investigator's missing link of fact, for it explained why the thrust bearing was cheated of lubrication, why the oil pump could not build up back pressure, and why the line bearings along the shaft had ample oil.

Report on this case stated that:

"The thrust bearing burned out beyond a reasonable doubt, because some person, or persons, unknown, inadvertently installed a crossover pipe that short-circuited the lubricating oil normally intended for the thrust bearing. This crossover was taken out too late to save the bearing."

Solving a problem in this way is successful chiefly because everybody can't cover up everything.

Fig. 3. Diesel engine failed after 10 months in service. Search for the cause disclosed these cracks in bed frame. Maker assumed liability for faulty casting

Three Heads Better than One

Most of our investigations are conducted as one-man projects. When the investigator is acknowledged to be competent in his engineering field, and the investigation is within this field, such a policy is quite satisfactory. However in important cases, where loss of life is involved or a considerable indemnity is at stake, as in insurance coverage and manufacturer's responsibility, the investigative body is most effective if it is formed of three persons.

The advantages of the multi-member body are these:

1: The members can toss the problems and questions back and forth freely, and in this way, unanticipated lines of investigation sometimes present themselves;

2: findings by a group sometimes are thought to be more representative of the actual conditions than are the findings of an individual;

3: there is less chance of error in forming the conclusions, and;

4: competence of a group is less likely to be later challenged than is competence of an individual. This can be an important point in court cases.

Open Mind Essential

In forming a multi-member board, one member must be designated as the senior member; his will be the responsibility for planning the investigation, and for conducting it with dignity and an open mind. Incidentally, any person who cannot undertake an investigation with an open mind should disqualify himself immediately. Keeping the eyes open for all facts in a case is not possible otherwise.

Having completed our investigation, with all facts assembled and our conclusions reached, we must set it all down on paper to make it part of the archives. A form suggested for this report consists of four sections as follows:

Section I: Presents a narrative of the casualty, identifying time and place, and indicating general nature of the happening; that is, whether it was fire, explosion, a physical failure, a collapse, etc. As a guide to the information submitted in this section, answer the questions: *Where, When* and *What.*

(*Note: How and Why are discussed in the conclusion.*)

Section II: The findings of fact by the investigator are enumerated as follows:

a. That (no) persons were killed and (none) injured.

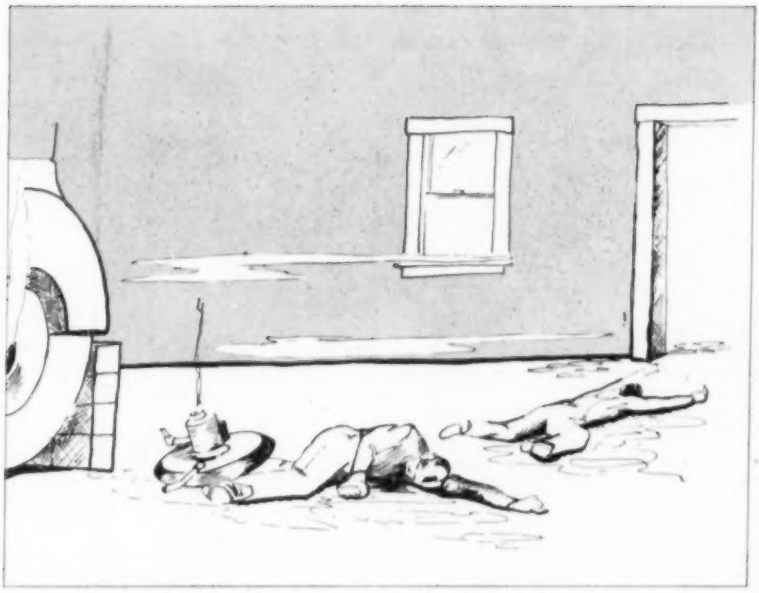


Fig. 4. Typical case for investigator is shown here. Oil burner blown out of Scotch boiler, two men dead—both scalded. Could you decide what happened?

b. That the (unit) which collapsed, (exploded, burned, etc.), was of (size-capacity) manufactured by (name) in (year). For piping, give size, working pressure, and type, valves, fittings, etc.

c. The extent of damage consisted of (describe)

d. That the weather (rains, winds, snow, etc.) did (or did not) contribute to the casualty.

e. Describe any other established conditions at the time which might or might not have contributed to the occurrence.

f. Give other pertinent facts which are considered in arriving at a conclusion. For example, in the collapse of the oil tank previously discussed, we might say: "The tank was not subjected to water hammer when the attendant closed the stop valve in the water supply piping, since this valve was outside the tank, and between the tank and the pump. Any shock wave set up by the sudden closing of the valve could not progress beyond this valve, and in addition, the tank top hatches were open to atmosphere, allowing liquid level to rise and fall freely."

Section III: Here present the conclusions as to how and why it all happened. As pointed out earlier, great care should be taken to make these conclusions credible beyond a reasonable doubt. *They must be supported by facts.*

In the absence of supporting facts, we can express opinions, but it must be emphasized that these are opinions or possibilities only, and that they are not conclusions. For example, in the case of the exploding refrigerator, possibilities were identified in this way: "ignition of the gas *might* have been provided by smouldering insulation outside the refrigerator door, or by the hot bulbs of the flood lights, by an electrical spark, or by a mechanical spark from the nail in someone's shoe striking a piece of metal, or by the striking of a match. But there is not sufficient evidence to fix the blame on any one of these possibilities beyond a reasonable doubt."

Get Facts, Don't Guess

As investigators we are paid to discover facts; anybody can guess.

Section IV: In this section, which we may or may not be asked to prepare, we offer recommendations for avoiding a repetition of the casualty in the future. These recommendations can range from material improvements, through design improvements, to operating improvements, or a combination of all three.

We can summarize the whole philosophy of an investigation in these words: Get the facts, and be sure that all conclusions are supported by the facts, and nothing but the facts, beyond a reasonable doubt.

Department of Commerce experts investigating air casualties have told this writer they can determine the cause of a plane crack-up beyond a reasonable doubt in 95 per cent of their cases, even when there are no survivors.

"There are sermons in stones," they say, "and engine parts, wing fragments, and in the way the earth is scored. The problem is to assemble *all* the facts, then the conclusions begin to take their proper forms."

If we can't find the facts in 95 per cent of our own investigations, perhaps our fact detecting is a little less thorough than it should be. This standard is a high one, but worth trying for.

Engineers To Build Own Center in Manhattan

UNITED ENGINEERING Trustees, Inc., the joint corporate agency of the four major national engineering societies, has signed a contract for preliminary architectural plans and studies for a new Engineering Center in mid-Manhattan, New York City. This is the first definite step toward construction of what is expected to make New York the "engineering capital of the world."

The architects named are Shreve, Lamb and Harmon Associates, designers of the Empire State Building and more recently the new Brooklyn Supreme Court Building. The announcement did not indicate any details as to specific location, cost or time of completion.

The present 16-story quarters, known as the Engineering Societies Building, house the four Founder Societies, the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. A fifth prospective Founder Society, the American Institute of Chemical Engineers, will be included in the Center project. At a recent meeting at which Mr. Barrett was re-elected and the architectural contract granted, the board of trustees of UET approved the American Institute of Chemical Engineers as a member. This action awaits ratification of the other four Societies.

The American Institute of Chemical Engineers now is located at 25 W. 45th St. Occupants of the Engineering Societies Building include Engineers Joint Council, which is composed of 10 major national engineering societies, including the five in the Founder group.

It is believed that preliminary plans will be completed early this year. The inclination toward a mid-Manhattan site is due to appreciation of accessibility of railroad and airline terminals and convention hotels.

Financing is expected to run into several million dollars. In addition to the contributions of the various Founder Societies and their members, UET, which has been charged with the responsibility of the planning, construction and financing of the new structure, has received assurances of the cooperation of a group of industrialists and educators toward the required fund.

This group, headed by Dr. Mervin J. Kelly, president of Bell Telephone Laboratories, Inc., stated on June 8, 1955, in a letter to UET and its constituent societies, its readiness to assist in this direction on the selection of a city following a broad and careful study of all possible sites with national rather than local interests to be the determining factor.

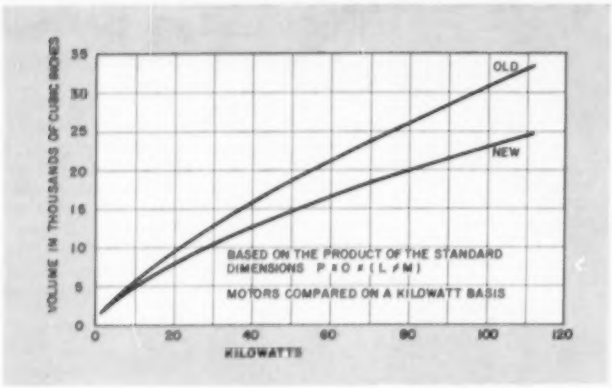


Fig. 1. Above. Relation between volume and kw for d-c motors showing reduction in volume with new NEMA Standards

Fig. 2. Below. Relation between weight and kw for d-c machines showing reduction in weight with new NEMA Standards

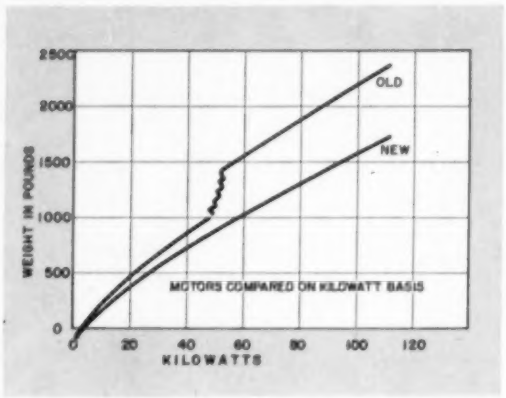
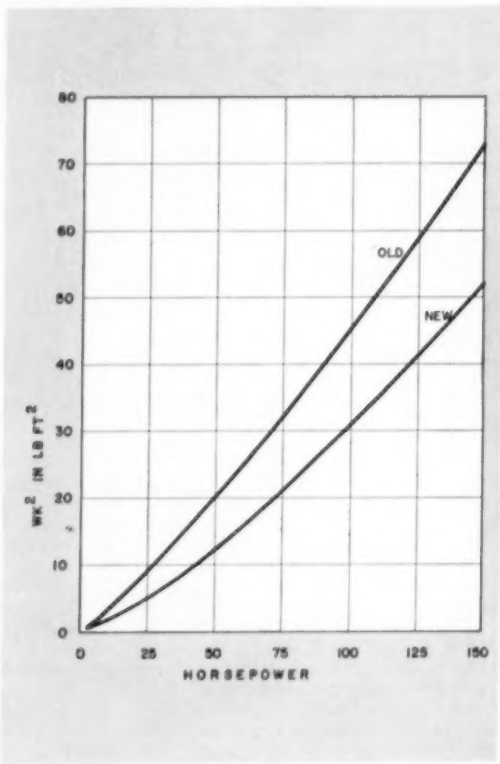


Fig. 3. Right. Relation between hp output and armature inertia—wk^2, for d-c machines under old and new standards



More D-C Power in Smaller Packages

NEMA Standards for d-c motors and generators are being revised to include improvements in materials and techniques. Here's how users will benefit from these revisions

By D. J. BUCKLEY, JR.*

DURING the 17 years that the present approved National Electrical Manufacturers' Association standards have been in existence, there have been many improvements or changes in the design, manufacture and use of d-c motors and generators. In order to give the users of d-c motors and generators the full benefit of all these improvements, the Direct-Current Motor & Generator Subcommittee of NEMA drew up a new proposed set of standards for this equipment. These standards have been approved by at least two-thirds of the member companies, and many are producing, or planning to produce in the near future, motors and generators to these proposed standards.

Since 1937, there have been significant improvements in the magnetic, non-magnetic and insulating materials used in d-c motors and generators. The war and post-war periods, which speeded up the research and development programs of many companies and divisions of the federal government, saw strides made in materials, processes, and design methods. These improvements have been introduced into manufacturing piecemeal as they have been made. Designers used them to their best ability within the framework of the NEMA Standards in existence at the time. However, with the new proposed standards for d-c motors and generators which the electrical industry has established, the full benefit of all these new methods and materials can now be passed on to the users. The standards were set up specifically for this purpose.

What are the main differences between the new proposed standards and the present standards? Under the present standards, general purpose motors of open construction with a continuous 40 C rating are considered standard. Class A insulation is used. Under the proposed standards, the standard line of motors will be of drip-proof construction with a continuous 60 C rating. Class B insulation will be used.

In the new standards, a drip-proof enclosure is established as the minimum enclosure, reflecting the trend of the past few years. Environmental

* Direct Current Motor and Generator Dept., General Electric Co

conditions of factories in many cases require motors to have this additional protection. The internal parts of the motor, particularly the commutator, are better protected with drip-proof construction. Further, more motors and generators are being used out-of-doors than in the past. The new machine has a 1.15 service factor.

Under the proposed standards, with the maximum temperature rise by thermometer increased to 60 C, the frame size of many ratings can be reduced. This means that the weight, volume and Wk^2 will be less than under the present approved standards.

The user stands to gain from lower cost, because he obtains the superior life characteristics of Class B insulation without the price adder normally associated with this feature. In addition, he has a drip-proof motor with a service factor at the same price he paid for a motor without this factor.

As previously stated, it is expected that volume, weight and Wk^2 will be reduced when motors and generators are designed to these proposed standards. But what of the magnitude of these changes and the advantages to be gained by them? Are they appreciable? Comparing the designs of General Electric d-c motors and generators under the proposed standards, with those under the current standards, the following changes are observed. Please bear in mind that the curves used in the following discussion are of average values, and individual ratings may not fall exactly on the curves. The speed rating of 1750 rpm is used in these curves as it is representative of the entire line.

Volume

In considering changes in volume, the following NEMA Standard dimensions for foot-mounted motors and generators are used:

P — Width of machine excluding conduit box

O — Height of machine excluding eyebolt

L+M — Total length of machine excluding shaft extensions

The product of $P \times O \times (L+M)$ is representative of the volume. As the saving in volume applies to both motors and generators, the curve shown in Fig. 1 is plotted on a kw basis. It can readily be seen by comparing the old and the new curve that volume on an average has been reduced 20 per cent throughout the load rating. Floor space requirements of motors, generators and sets in a user's plant will be correspondingly less. The number of cases where a space problem is involved will be considerably reduced. Equipment manufacturers will have more leeway in the design of their equipment using d-c motors and generators.

In Fig. 2 a weight comparison is made on a kw basis. The average reduction in weight is 25 per cent. This means lower transportation costs and easier handling for the user.

One of the most important benefits for users of d-c motors and generators under the new proposed standards is reduced armature inertia, due in large part to the reduced volume and weight. This is of the greatest importance in motor design because of the many changes in speed, torque, and direction encountered in d-c motor operation. The comparison is therefore made on a hp basis in Fig. 3.

As can be noted from the curve, an average 35 per cent reduction in armature inertia has been achieved. The greatest reduction in armature inertia on a lb ft^2 basis occurs at conditions of high speeds. This is due to the greater reduction in volume and weight at higher speeds.

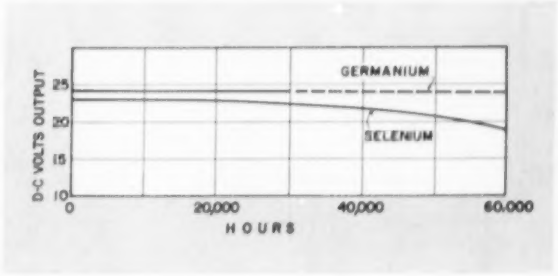
The speed of response of a d-c motor changes inversely as armature inertia changes. Thus, a reduction in armature inertia of 35 per cent for a given rating of 1750 rpm means an increase in speed of response of over 50 per cent. With less time required to make changes in speed, processing time is reduced for certain applications.

Conclusion

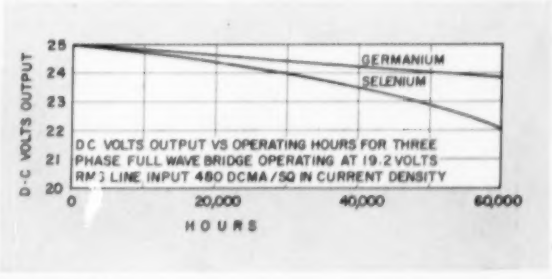
Direct-current motors and generators designed to the new NEMA proposed standards for future design offer users the benefits of reduced weight, volume, and Wk^2 with Class "B" insulation at approximately the same cost as drip-proof machines built to the present approved NEMA standards. As new procedures, processes, and materials are developed, purchasers of d-c motors and generators can look forward to further improvements.

What You Should Know About Germanium Rectifiers—Correction

IN THE ARTICLE with the above title, in our Dec. 1956 issue, an error was made in drawing the curves in Fig. 4 of the article. The incorrect curve, as published, is shown below, right; correct curve is at the right. The correct curve shows d-c volts vs operating hrs for a 3-phase full-wave bridge rectifier, force cooled in a 40 deg ambient, with a line input of 19v RMS, and current density of 0.365 amp d-c per sq in. for the selenium, and 333 amp d-c per sq in. for the germanium. Note that germanium exhibits no aging.



Correct



Incorrect

Note About Maxwell's Chart, December Issue

Some readers of the article: Maintenance Is a Business—Make It Produce! Part II, December 1956 POWER ENGINEERING, pages 106 to 109, have reported that they received copies in which the reproductions of Fig. 1 (in green) were so lightly printed that they are not easy to read. We now have some clear, sharp, black and white reproductions of the chart enlarged to 7 by 10 in. and will send a free copy to you on request to the Editor.

Monitor for Peak Combustion Efficiency Measures O_2 Content in Flue Gases

NEW FLUE GAS monitoring system is designed to assure peak combustion efficiency, for greater fuel economy in utility and industrial power plants. The system employs accurate and reliable analysis of the O_2 content as a measure of excess air, and can automatically adjust fuel-air ratio to maintain optimum combustion.

In one typical installation on a twin furnace for superheat and reheat at Philadelphia Electric's Cromby Station, the system detects, within 13 sec, a change in flue-gas oxygen at the sampling point some 150 ft from the analyzer. The recorded oxygen content, obtained from 3 sample points and averaged, checks the average of Orsat readings within 0.2 per cent O_2. In operation over a year, the system has proved reliable and has won the confidence of operators and test engineers, requiring little attention other than routine maintenance.

O_2 Content, Basis For Control: Many combustion engineers have believed for some years that O_2 content in flue gases is an ideal basis for combustion control. It provides a direct measure of excess air which operators want to hold at an optimum value. Too little air means wasted fuel due to incomplete burning; too much air means loss of valuable Btu's up the stack.

The O_2 content holds its direct relation to excess air in spite of variations in the fuel's heating value, specific gravity, or type. For example, 6 per cent, O_2 in the flue gas indicates close to 40 per cent excess air with only a 0.1 per cent O_2 spread between values for natural gas and oil. On the other hand, the spread between CO_2 readings at 40 per cent excess air for oil and gas is approximately 3.5 per cent CO_2. This means that with CO_2 the operator has no direct, meaningful index of excess air when mixed fuels are fired. O_2 on the other hand measures excess air directly.

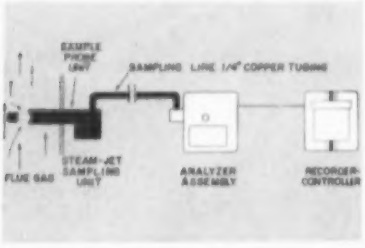


Fig. 1. Basic components of the oxygen analyzer system of combustion control

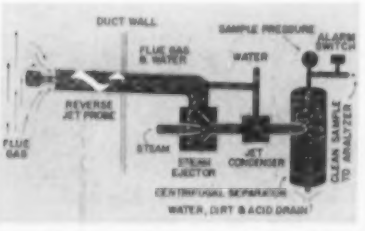


Fig. 2. Jet condenser and centrifugal separator which clean flue gas sample

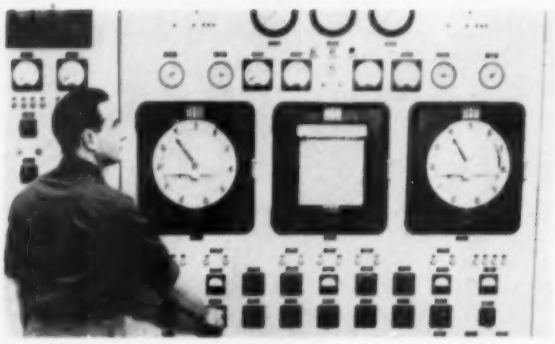


Fig. 3. Portion of panel board in control room at Philadelphia Electric's Cromby Station showing O_2 recorder-controllers (circular chart instruments at extreme left and right)

Basic Components of System: Control system has 4 basic components: one or more probe units for gas sampling; a gas cleaning unit for each probe; magnetic-type O_2 analyzer assembly; and electronic recorder-controller for O_2 (Fig. 1).

Key component, designed to make the system practical, is the reverse jet probe and associated steam sampler (Fig. 2). Three water jets from the reverse jet head on the probe end keep the probe clean with a high velocity, swirling stream. A steam ejector provides a strong suction to draw the flue gas sample into the probe and force it at high speed to the analyzer.

A jet condenser and centrifugal separator (Fig. 2) clean the flue gas sample, which passes to the analyzer through standard ¼-in. copper tubing under a pressure of 3 to 6 psig. This line to the analyzer can be up to 200 ft long with as little as 6 seconds lag in sampling.

The gas sample enters the analyzer through a separator, which removes any condensate formed in the sampling line. It then passes through a filter and by-pass assembly that maintains a constant rate of flow through a rotameter to the analysis cells.

In the analyzer, the oxygen content is measured by the para-magnetic properties of oxygen (i.e., it is strongly attracted to a magnetic field). Through an electrical circuit, designed to eliminate errors due to changes in sample gas or atmospheric pressure and variations in supply voltage, the analyzer compares the O_2 content of the flue gas to the very stable O_2 content of atmospheric air and produces a signal directly proportional to the O_2 content of the flue gas. The electronic recorder measures this signal and records the O_2 content directly in per cent of oxygen (scale range is normally 0 to 5 per cent O_2, or 0 to 10 per cent O_2).

Use of Multiple Probes for Average Sample: In modern boilers having big ducts, or in process heaters, stratification of flue gas is a common cause of misleading information about combustion. Gas sampling traverses made by test engineers across the ducts on big boilers show that O_2 readings can be 1.5 per cent O_2 apart — in the same duct and at the same time. This corresponds to a variation of about 10 per cent in excess air.

At PE's Cromby Station, each furnace has 3 sampling probes which feed a panel-mounted sample-averaging unit. Here, samples are combined on a metered flow basis to get a true average sample for the analyzer.

Want More Information?

For additional details on this new system, write the Editor, POWER ENGINEERING, 110 S Dearborn St., Chicago 3, Ill., or jot Combustion Monitor on the return postcard elsewhere in this issue.

How Soon Will We Get Fusion Power? —A Progress Report

Most work in the field of thermonuclear research in the U. S. is still classified but lately there has been a tendency to discuss the nature of some of the problems a little more openly. Here are presented some of the recent disclosures of work that is going on in this field

By ANDREW W. KRAMER

Editor, Power Engineering

SHORTLY after World War II, sometime around 1950, a few scientists at Los Alamos Scientific Laboratory began thinking about a fascinating problem, one which, if it can be solved, will stand for all time as man's greatest achievement. At that time the basic principles of nuclear power development were well understood and the fusion reaction of the hydrogen bomb was a virtual reality. Though there was little commercial interest in nuclear power it was a generally accepted fact that nuclear power plants would be built in future years.

It may have been as a sort of relaxation after the strenuous and concentrated effort put forth in the development of the atomic bomb or perhaps merely because they were scientists that these men began to speculate on an old crackpot idea; the idea of burning water! They felt that this might not be such a crackpot idea after all. What they had in mind was a controlled thermonuclear reaction; instead of developing power by the fission of uranium, they would do so by the *fusion* of light elements such as hydrogen. This, of course, was the reaction underlying the hydrogen bomb. Now, the question was, could this reaction be controlled so as to serve as a source of power? If it could, then there was a fair possibility that some day we might be able to burn the hydrogen in water.

Since this thinking was being done at Los Alamos, it was, of course, classified. At that time almost everything at Los Alamos was classified. At Princeton University, however, Lyman Spitzer, not knowing about the classified work going on at Los Alamos, began to think about the same idea and proceeded to invent something by himself. His work was recognized by the Atomic Energy Commission, so they proceeded to subsidize him. This was the beginning of Project Sherwood — the AEC's name for the thermonuclear research program being carried on at three different places — at Los Alamos and Livermore laboratories and at Princeton University. Since that time, work on the project has intensified but until recently, virtually nothing has been disclosed concerning progress. The McKinney Report on the Peaceful Uses of Atomic Energy, issued early last year, contained the first more or less official discussion of the problems involved in this field of nuclear research but no details were mentioned.

It is curious and somewhat tragic that the first detailed information concerning experiments in fusion reactions had to come from Russia. The most dramatic and significant event since the Geneva conference came with Russian scientist Igor Kurchatov's astonishing talk on fusion power, delivered during a visit to Harwell (the British Atomic Energy Establishment) on April 26, 1956. With this one speech the Russians moved well ahead of the U. S. in the extent of declassification of thermonuclear information. Kurchatov gave a responsible account of experiments basic to the eventual realization of controlled thermonuclear power. His British listeners were greatly impressed, as were those in the U. S. outside the AEC. U. S. AEC observers generally would not comment on the speech but all implied it was quite good.

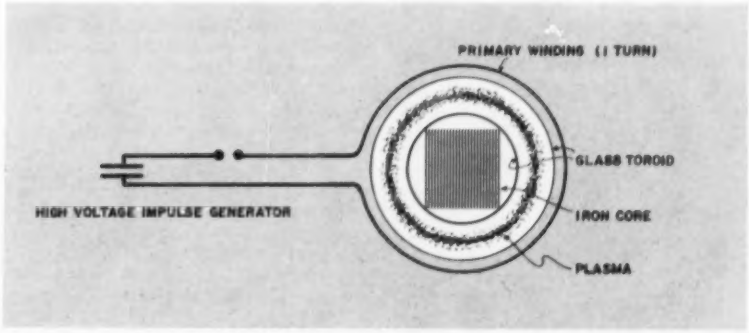


Fig. 1. Refined model of an early "Perhapsatron". It consists essentially of a glass toroid containing deuterium gas surrounded by a single turn primary winding. The plasma in the tube then becomes the secondary winding of the transformer

Why Thermonuclear Research?

As pointed out in *Nucleonics*,* it was unfortunate that the initiative in this field was left to the USSR. Many non-AEC scientists on this side of the Atlantic have long urged declassification of fusion-power experiments because the opening up of this subject would speed the realization of this new source of power.

Since Kurchatov's speech there actually has been a slightly more liberal tendency to discuss the subject in the U. S. Last June at the Denver Conference of the Atomic Industrial Forum, Amasa Bishop of the AEC presented a short paper on the basic principles of the controlled thermonuclear program, and at the winter meeting of the American Nuclear Society held in Washington, D. C. last December, an entire session was devoted to the subject of thermonuclear reactions. Great attendance at this session indicated the interest.

Before considering some of the basic principles of fusion research it may be well to ask, why is this field of research so important? We have just learned how to produce power from fission and this seems to insure our power supply for many years ahead. So why become so concerned about a completely new, and obviously much more difficult problem?

The answer to this question lies in the extremely rapid rise in our use of electric power throughout the entire world As is well known our electric power load has been doubling every ten years for the last four decades.

* For complete transcript of Kurchatov's address see *Nucleonics*, June 1956, p 36.

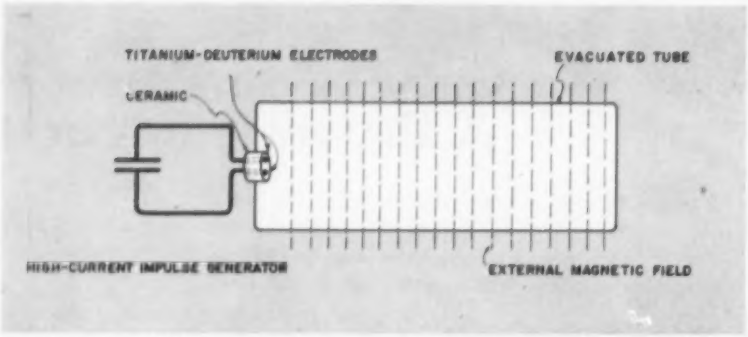


Fig. 2. Details of Dr. Bostick's plasma gun. The gun consists of two tiny wires embedded in a small ceramic disk about the size of the eraser on a lead pencil. Gun fixed in end of evacuated glass tube excited by external magnetic field

Assuming that this rate of rise will continue — and we have no reason to assume otherwise — and looking ahead only 100 years, we will be using 1000 times as much energy as we do today. If this actually happens, how long would our present conventional fuel reserves be able to supply the demand? The answer is quite startling. At this rate our present oil reserves would last only two months; our coal three years; and even assuming the full scale development of nuclear energy from fission, the uranium and thorium reserves would last only 25 years. With thermonuclear power, however, the deuterium in the oceans would supply us with power for at least a billion years.

The success of the thermonuclear power program, therefore, means the solution of the world's future energy problem. Even solar energy could not sustain a power demand of 1000 times the present demand because it would mean the recovery of solar energy from about 10 per cent of the earth's surface. If we could use deuterium, power would be practically unlimited. If one turned on a faucet in one's kitchen, the deuterium in the stream (one atom in 6000 of ordinary water) would supply all the power needed in the U. S. at present.

With fission and the present type of nuclear reactor, the radioactive waste disposal problem becomes the source of a terrific headache, and there is always the chance of an accident releasing great amounts of dangerous radioactivity.

With fusion, on the other hand, there would be no waste disposal problem and there would be little danger from radiation or from accidental explosion. The thermonuclear reactor would be quite safe. All the fuel except the little that was in process of being converted into power would be on the outside of the reactor, and, perfectly safe. But even more important, the thermonuclear reaction for the first time makes possible the direct conversion of nuclear energy into electricity. No heat exchangers, boilers, turbines or electric generators would be needed. *Perhaps!*

Basically, the problem of producing power from thermonuclear reactions is simple. Merely take a quantity of gas, deuterium gas for example, and heat it to a hundred million degrees, and you have thermonuclear power. It's the 100 million degrees that makes it difficult.

Basic Principles

The fusion process is in many respects just the opposite of fission. In fission we are dealing with the splitting up of very heavy uranium nuclei. In fusion we are dealing with extremely light nuclei and are attempting to fuse them together to produce heavier (and more tightly bound) nuclei. Of the various possible reactions from which energy is obtainable by the fusion process, those of primary interest involve the isotopes of hydrogen. One of the more important may be written as follows:

$$D + T \longrightarrow He^4 + n + 17.6 \text{ Mev}$$

A deuterium nucleus, which is here designated by the symbol D (and which is simply an isotope of hydrogen having one neutron in addition to the proton) may be caused to undergo fusion with a tritium nucleus, designated by T (which is another isotope of hydrogen consisting of a proton with two additional neutrons). This reaction yields a Helium-4 nucleus and a neutron, *and* 17.6 million electron volts of energy released in the process.

Another reaction of still greater interest (in that it expresses the ultimate goal of the Sherwood program) is that involving simply deuterium nuclei alone, and this is written as follows:

$$D + D \longrightarrow \begin{cases} He^3 + n + 3.2 \text{ Mev} \\ T + p + 4.0 \text{ Mev} \end{cases}$$

Here there are two alternative reactions which may take place with roughly equal probability.

Note that in all of these reactions energy is released in the fusion process. This energy results from a transformation of mass into energy, the total mass of the nuclei on the right side being less than that of those on the left side. This energy appears in the form of kinetic energy of the reaction products, the lion's share going to the lighter of the two nuclei.

While these equations are simple enough there are a number of formidable difficulties to be faced in the development of controlled thermonuclear reactions. The first difficulty is that exceedingly high temperatures (hundreds of millions of degrees) are required in order for the fusion reactions to occur. To cause nuclei to undergo fusion, these nuclei must be brought sufficiently close to one another so the nuclear forces may interact and permit fusion to occur. The nuclei are all positively charged and repel each other strongly by virtue of the Coulomb law of electrostatic repulsion. To cause them to collide with one another it is necessary to give them sufficiently high velocities so that they overcome the force of repulsion.

Since the chances of elastic scattering of the nuclei far exceed the chances of the fusion process occurring, the nuclei must be confined to some limited region and made to approach one another time and time again until actual collision and fusion eventually does occur. This condition of having the particles in a confined region and moving at high velocities randomly with respect to one another corresponds to having the deuterium at an extremely high temperature. The energies which are required for the fusion process to occur correspond to temperatures of 100 million degrees or more — temperatures higher than those which exist in the interior of the sun.

The second difficulty, one which is related to the first, is that only those elements of extremely low atomic number (Z) can be considered as possible fuels in fusion reactions. The reason for this is that the coulomb force of repulsion (which may be written as $F = Z_1 Z_2 e^2 + r^2$ increases with the Z values of the interacting nuclei, and hence the temperatures which are required to overcome these forces of repulsion increase very appreciably. It is for this reason that the isotopes of hydrogen (with their Z values of 1) are particularly interesting. Other elements with higher values of atomic number are not out of the question as possible fuels, but they would require much higher temperatures than even the several hundred million degrees now being considered.

A third requirement of any controlled thermonuclear reaction of interest is that it be self-sustaining. At these extremely high temperatures, all of the fuel atoms are completely stripped of their electrons, and we are dealing with a wholly ionized gas or plasma, as it is called. This plasma, consisting of charged nuclei and electrons in constant collision, radiates energy at a very appreciable rate by the process of bremsstrahlung — that is, as a result of constant collision between electrons and ions. Now,

clearly, no isolated plasma can stay at a high temperature if it radiates energy faster than it generates it. Thus, there is a minimum temperature below which the reaction cannot sustain itself as a result of its internal energy generation. This so-called *ignition temperature* turns out to be independent of the density of the plasma, and for the D-D reaction is of the order of 400 million degrees Kelvin. For the D-T reaction it is somewhat lower.

Since radiation losses rise rapidly as a function of the atomic number of the fuel involved (i.e., as the square of Z) the ignition temperatures for fuels other than hydrogen isotopes is much higher. Even traces of heavier elements in the plasma in the form of impurities would result in a substantial increase in the energy losses from the plasma by radiation. Consequently high purity is also a prime prerequisite.

Confining the Plasma

A fourth requirement — one that was briefly mentioned earlier in this discussion — is that of providing adequate confinement at these temperatures for a sufficiently long period of time so that an appreciable fraction of the nuclei can undergo fusion. Clearly no materials can withstand these enormous temperatures, so some other means must be found to confine the plasma. In the case of the sun, forces of gravitation serve this purpose and prevent the plasma from escaping from the hot region. Gravitational forces, however, are much too weak to be of any value in any controlled thermonuclear devices on earth. The only way we know of to confine the plasma and prevent it from vaporizing the walls of the reaction chamber is by the use of electric or magnetic fields.

The way in which a magnetic field may serve to confine a plasma may be described in the following way: If a group of charged particles of the plasma are in a region in which there is *no* magnetic field, these particles will move in straight lines (except that they may be deflected as a result of scattering from one another) and will eventually strike the walls of the reaction chamber. If, however, a magnetic field is applied, the paths of these same particles will no longer be straight, but will be bent into tight helices encircling the lines of force of the field. The only way then in which these particles can move outward to the container walls is through a process of diffusion as a result of collisions with other particles, which thereby changes their instantaneous center of curvature. Thus, in the presence of a magnetic field, the outward movement of particles in a plane perpendicular to the magnetic field itself is limited to a diffusion process, in which the rate of diffusion varies inversely as the square of the magnetic field (and which thus may be kept to small values by the application of sufficiently strong fields). It must be pointed out, however, that the motions of particles *along* the lines of magnetic force are unimpeded, and special techniques must be invoked to prevent this mechanism of particle loss from the hot region.

In this process of confinement, therefore, the magnetic field may be looked upon as a mechanism for exerting pressure directly upon the plasma. The confined plasma itself exerts an outward gas pressure of magnitude NkT (where N is the number of charged particles per cc, T is the temperature in degrees K, and k is Boltzmann's constant). This outward pressure by the plasma must be confined by the inward pressure which the magnetic field is capable of producing, and which may be written as $H^2 \div 8\pi$. A simple calculation will show that with the magnetic field strengths available in the laboratory it is theoretically possible to confine a gas at temperatures and densities which will yield significant amounts of nuclear power from the fusion reaction.

Some Major Problems

It is necessary that the mechanism of confinement be a stable one, that is, instabilities must not be permitted to develop whereby the plasma might squirt through the confining field and reach the material walls of the reaction chamber. Finally, but by no means least, is the requirement of extracting the energy released in the fusion process and converting it into useful energy.

Recapitulating briefly the major problems: One must choose a suitable material of low atomic number, ionize it to form a plasma, heat this plasma to temperatures of hundreds of millions of degrees, confine it by some suitable means at that temperature for a sufficient time to permit an appreciable fraction of the ions to fuse together with consequent release of energy, and finally to harness this energy and convert it into useful power.

As explained by Amasa Bishop in his address at Denver last June, in the AEC Sherwood program, there are a number of alternative approaches which are being pursued. These involve different configurations and mechanisms of plasma heating and confinement. The major programs are under way at Princeton, Los Alamos and Livermore. In addition there are smaller projects under way at Oak Ridge, New York University and several other sites. All of the work is still very much in the research stage, and it is anticipated that many years of intensive work will be required to develop a prototype thermonuclear device which might yield more energy than it consumes. After that, many more years would be required to develop a full scale device which might have a chance of competing economically with other sources of power.

As already pointed out, if a source of controlled thermonuclear energy can be developed, it would differ in a number of interesting and important ways from fission reactors:

1. In contrast to a fission reactor, a full-scale controlled thermonuclear device (an *astrodyne*, as Mr. Bishop said he liked to call it) would contain only a minute amount of fuel in the reaction chamber at any one time. The fuel supply itself would be retained outside the chamber at room temperature. Consequently the possibility of an explosion or loss of control would be practically non-existent.

2. Unlike a fission reactor, the problem of radioactive nuclear wastes is not present. The products of fusion, if the nuclear burning is carried

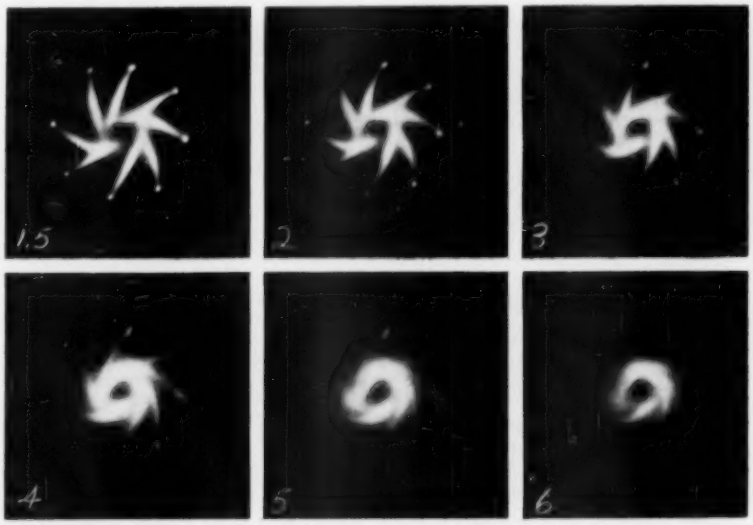


Fig. 3. Sequence showing evolution of miniature eight-armed galaxy in the laboratory. Simulates in fraction of second what occurs in space in a billion years

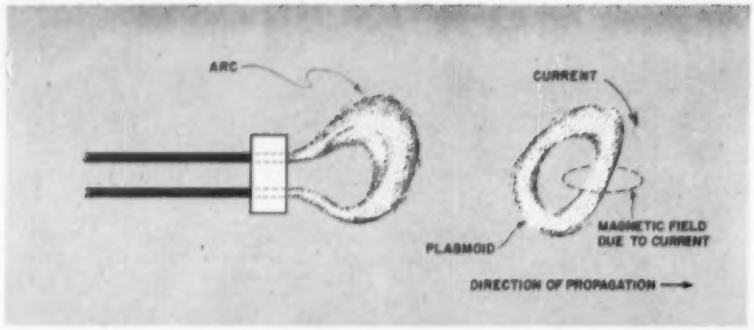


Fig. 4. Diagram showing the formation and propagation of a plasmoid from gun

to its proper completion, would consist of non-radioactive nuclei only.

3. One additional factor of potentially great importance is the possibility of direct generation of electric power without the necessity of going through a heat cycle. This possibility arises from the fact that, in the D-D reaction, for example, more than ⅔ of the released energy is emitted in the form of charged particles which, because of their charge, will not be able to escape from the field which confines them. Since this confining field is itself electromagnetic in character, the interaction of the released energy back on the confining field may, under proper conditions, be expected to result in the direct generation of electrical power.

Experimental Techniques

Consideration of the various possible ways of generating intense controllable thermonuclear processes shows that there are quite a number of directions that can be followed. On the one hand there are approaches that lead to stationary state thermonuclear reactions, and on the other those that are based on the idea of utilizing an instantaneous temperature rise in transient processes of very brief duration. Kurchatov in his Harwell address referred to both methods but said practically nothing about the stationary process. He described the pulsed discharge techniques which the Russians have been following.

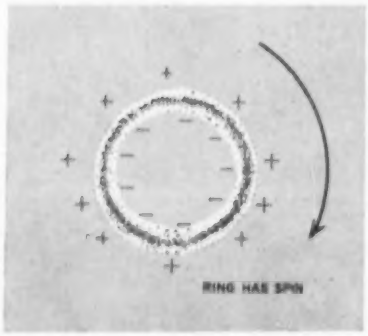


Fig. 5. Structure of a plasmoid. The ring consists of titanium ions, deuterium ions, and electrons, the electrons occupying the inner portion of the ring and the positive ions, the outside. The ring thus formed is believed to possess spin as well as to possess magnetic moment

This method consists of sending high current pulsed discharges through various gases at pressures ranging from 0.005 mm Hg to 1 atmosphere. In the case of the Russian experiments most of the work was with straight discharge tubes, the length of the gap varying from several centimeters up to 2 meters and the diameter from 5 to 60 cm. The discharge was produced by voltages of several tens of kilovolts. Peak currents varied from 100 kiloamp to 2×10^6 amp. The rate of current rise was between 10^{10} amp per sec and 10^{12} amp per sec. The maximum instantaneous power released in the plasma was as much as 40×10^6 kw. Banks of high voltage condensers were used to produce the discharges.

When currents of such magnitudes are established in gases, the discharges are subject to the *pinch effect*, the result of an electromechanical force that constricts gaseous or molten conductors. Under this effect, the plasma detaches from the walls of the tube, its temperature increases, and the cross section of the discharge is greatly reduced. As explained by Kurchatov, from the viewpoint of gas dynamics, the contraction process should be considered as a phenomenon in which a cylindrical shock wave converging toward the axis is produced in the plasma. The final stage of cumulative contraction sets in when the plasma, accelerated by the magnetic field (due to the current), reaches the axis At this moment a great part of the energy of ordered motion changes into heat, and the pressure and plasma temperature sharply increases. During maximum contraction, the plasma temperature may be of the order of a million degrees C.

Space limitations do not permit of a detailed account of the results discussed by Kurchatov but one of the most interesting effects of these intense pulsed discharges was the appearance of penetrating radiations. In 1952, soon after the Russian work began it was found that the discharges became the source of neutrons. At first it was thought that this neutron production might be due to thermonuclear reactions but subsequent experiments threw doubt on this point and at the present time there is still uncertainty as to the exact nature of this neutron production.

U. S. Work

It is quite apparent from the unclassified discussion that has taken place in the United States recently that work on this side of the Atlantic, in part at least, is along the same lines as in Russia. We also are working with high-current discharges through gases. At the American Nuclear Society meeting, Dr. J. Tuck of Los Alamos Scientific Laboratory presented a most interesting discussion on the theory of the pinch effect and its instabilities. He described discharges in a circular tube, energized by an external primary winding supplied from a high-voltage oscillatory current generator. The gas in the tube formed a single turn secondary of a transformer, in fact the apparatus actually had an iron core.

One of the most significant papers presented at the ANS meeting, however, was a discussion by W. H. Bostick of Stevens Institute of Technology on the behavior of *plasmoids*. By means of a plasma gun which projects ionized matter at speeds up to 2×10^7 cm per sec it is possible to produce *plasmoids* (plasma magnetic entities) when the plasma is projected into an externally excited magnetic field.

The plasma gun, about the size of an eraser at the end of a lead pencil, consists of two tiny wires embedded in a ceramic disk with the ends of the wires flush with the face of the disk. An electric arc is formed between the ends of the wires by a half microsecond pulse of current having values as high as 10,000 amp. The wires are of special composition, titanium with deuterium absorbed or occluded in it. Due to the tremendous current density the tips of the wires are heated to temperatures high enough to vaporize and ionize both the titanium and the deuterium. The gun is placed in an evacuated space excited by a strong magnetic field. Under the action of this magnetic field, the arc or *plasmoid* is hurled from the gun at speeds up to 2×10^8 cm per sec, equivalent to 7500 miles per sec. This is the highest speed that matter of such density — amounting to a veritable river of atoms — has so far been attained on earth. The temperature of the deuterium ions in these plasmoids is of the order of 4,000,000 K.

Such plasmoids exhibit remarkable stability and interesting properties. When two or more such guns are directed against each other, the plasmoids can be scattered off one another, and can be shown to possess magnetic moment. Using the plasma guns in this *continued on page 112*

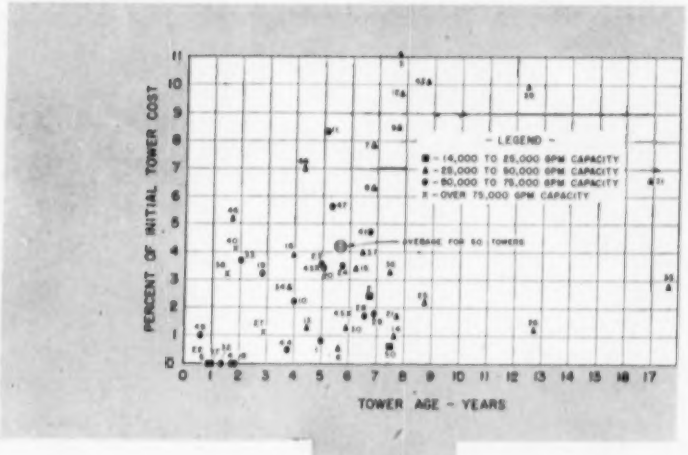

PERCENT OF INITIAL TOWER COST
TOWER AGE - YEARS
- LEGEND -
■ - 14,000 TO 25,000 GPM CAPACITY
▲ - 25,000 TO 50,000 GPM CAPACITY
● - 50,000 TO 75,000 GPM CAPACITY
X - OVER 75,000 GPM CAPACITY
AVERAGE FOR 50 TOWERS

Fig. 1. Typical chart made up from questionnaire information

What Does Cooling Tower Maintenance Cost?

APPLICATION of cooling towers in the circulating-water systems of steam-electric power plants has closely followed the growth of the electric utility industry in the expansion period since World War II.

Cooling towers permit considerable flexibility in system planning by not restricting plant locations to the vicinity of large bodies of water. Instead, power plants can be located more efficiently near fuel sources and load centers.

Restrictions are increasing on the rejection of heat into small lakes and streams because of the detrimental effect on fish life, and good sites on large rivers are becoming hard to find owing to the competition from other industries needing large quantities of cooling water. For these and other reasons, the number of cooling towers in this country may be expected to increase steadily in the future.

Size of units will probably vary only slightly from present day sizes, since the increase in size that would be required by the large units will probably be offset by the reduced cooling water quantities obtained through improved steam-cycle development. This improvement is clearly shown by the curves in Fig. 2.

Selection of a cooling tower system, as opposed to an open type cooling arrangement using rivers, artificial ponds, lakes, or ocean bays is an economic choice, and the costs of cooling tower operation must naturally take into account first costs, fixed annual charges and maintenance costs.

As pointed out by M. W. Larinoff, in ASME paper No. 56-A-59, cooling towers would find greater acceptance today if it were not for performance and maintenance problems which generally have been greater than those encountered with the conventional open-type circulating systems.

It is difficult to generalize about maintenance costs unless a sufficient number of pieces of equipment are studied and cost categories are well defined and established. To present such experienced maintenance-cost data, a questionnaire was sent to the management of a number of operating electric utilities who agreed to review and summarize all their cooling tower maintenance costs in accordance with a requested form. This survey covered a total of 50 cooling towers aggregrating 2,600,000 gpm of cooling capacity serving 3,500,000 kw of installed generating capacity. The smallest tower was 14,000 gpm and the largest 160,000 gpm; none was over 18 years old and only four were over ten years old. The average tower was of 52,000 gpm capacity and was 5.7 years old.

Figure 1 shows one of many charts made up from the information given in the questionnaires, and Fig. 3 shows a summary of all the charts. This data covers all the cooling towers operated by the utilities; not one tower was omitted from the study.

The towers studied were the conventional redwood type. As Mr. Larinoff pointed out, cooling tower owners with towers less than 10 years old who have already spent more than 50 per cent of the initial tower cost for maintenance could probably have well afforded a concrete-shell cooling tower with a fill of noncorrosive metal or some plastic material lasting perhaps 30 to 40 years. The answer to a dependable, durable, and economic cooling tower may not be in today's redwood towers nor in an indestructible substitute material tower, but it should lie somewhere in between.

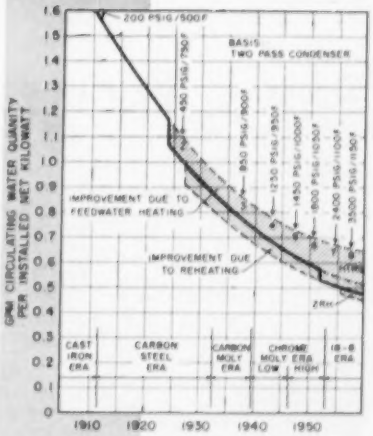


Fig. 2. Chart showing improvement in steam cycle 1910–1960

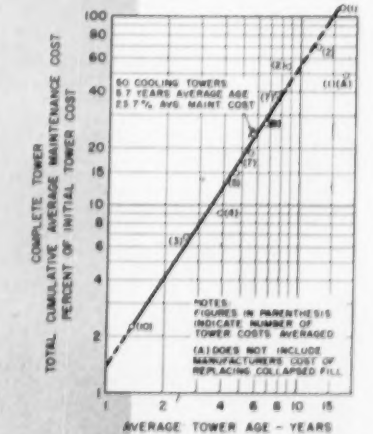
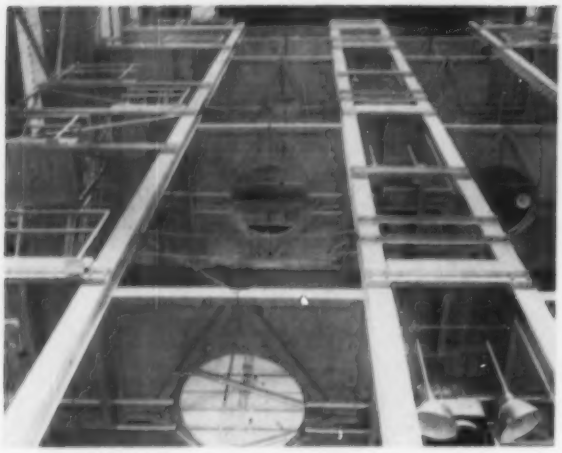
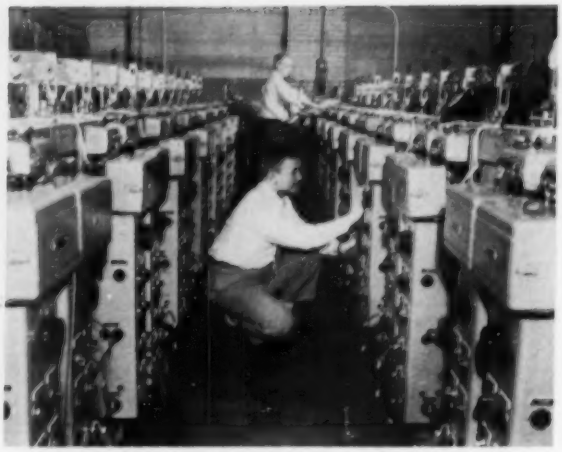

TOTAL CUMULATIVE AVERAGE MAINTENANCE COST
PERCENT OF INITIAL TOWER COST
50 COOLING TOWERS
5.7 YEARS AVERAGE AGE
2.5 7% AVG. MAINT COST
NOTES:
FIGURES IN PARENTHESIS INDICATE NUMBER OF TOWER COSTS AVERAGED
(A) DOES NOT INCLUDE MANUFACTURERS COST OF REPLACING COLLAPSED FILL
AVERAGE TOWER AGE - YEARS

Fig. 3. Chart showing effect of age on average maintenance



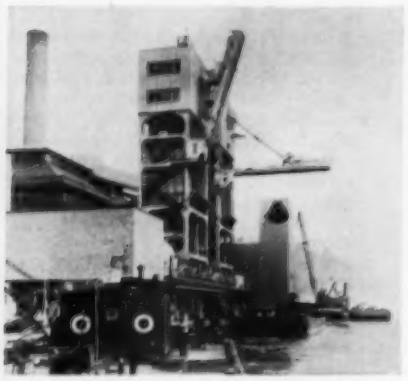
King-sized test stands at Baltimore plant of The Martin Co. are ready for assembly and testing of Vanguard, three-stage rocket vehicles which will launch Navy's earth satellite during geophysical year. Next stop, outer space



Creep and rupture qualities of metal alloys are tested in these high-temperature furnaces at a GE laboratory. Tests help develop new alloys to resist increasing pressure and temperature effects on blades of modern turbine designs

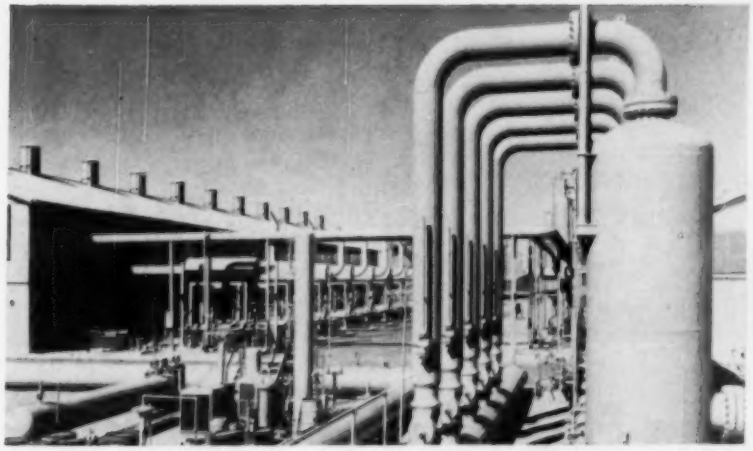
POWER ENGINEERING'S *NEWS REEL*

Big push is on at B. C. Cobb Plant of Consumers Power Co., Muskegon, Michigan. Caterpillar tractor with special Balderson U-blade shoves 19 to 20 tons of coal at a time. On 250-ft course, tractor handled 633 tons per hour

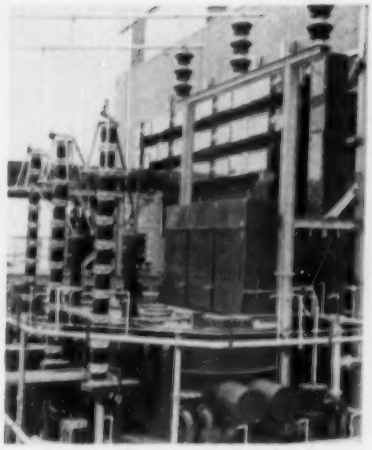


Coal for N. Y. Subways is now unloaded by new towers. This site demanded structures of good appearance

Insulation that processes itself in service is used at N. Y. airport. Called Gilsulate, material is poured on hot water pipes. When pipes heat, product around pipes becomes a waterproof semi-plastic; next is layer of sintered particles; remainder is unaffected. Photo above shows 1100-ft trench for hot-water heating system, one of the largest

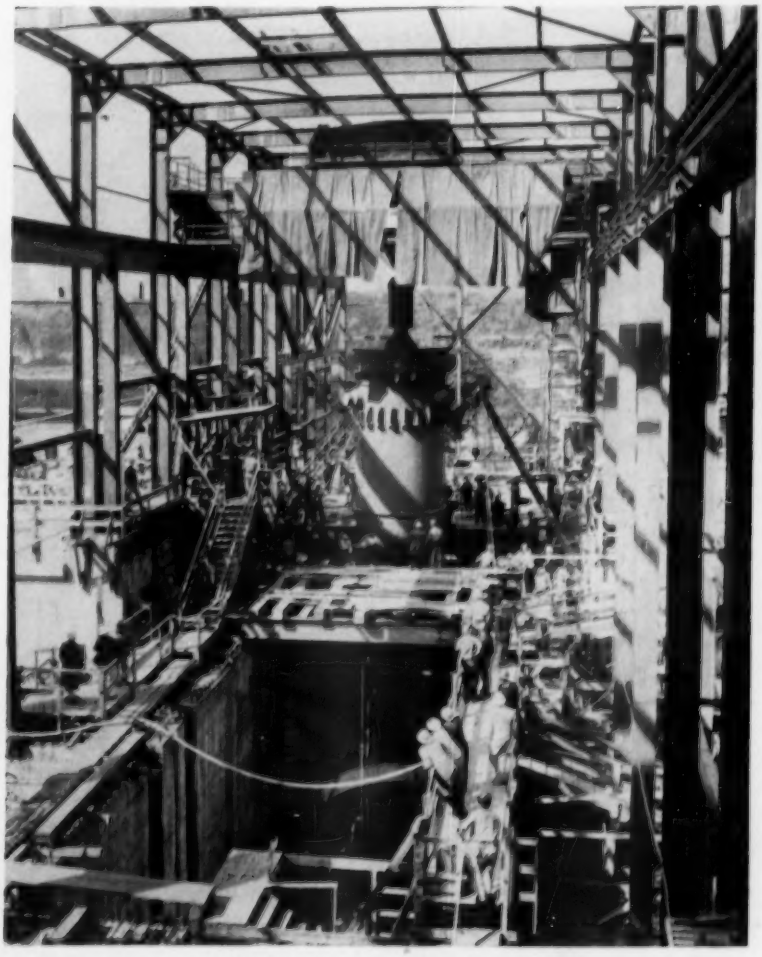


Six miles of piping in new gas compressor plant makes attractive picture of symmetry in design. Plant has seven compressor units weighing 83 tons each, plus 300 more tons of equipment

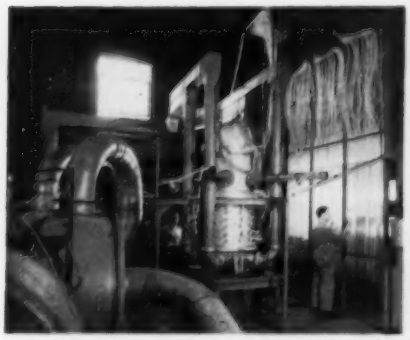


Cooling by forced air is news with a 10,000-amp isolated phase bus like unit shown here. GE-designed and built, bus carries power from generator to transformer at CEI's Eastlake plant.

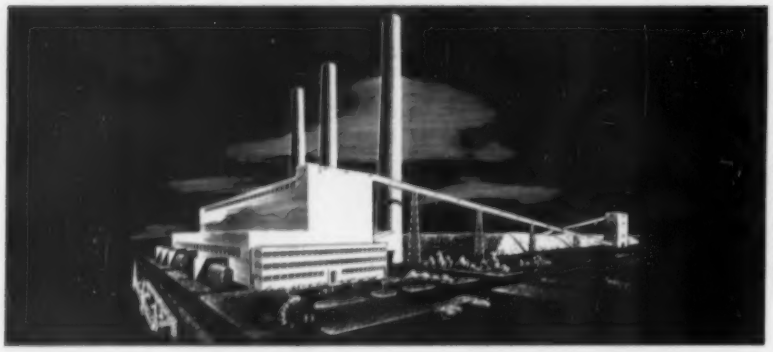
More new power for Ohio River Valley. Here is a view of 670,000-kw Kammer Plant to be built by Ohio Power



Tense moment at Shippingport as Westinghouse 150-ton atomic reactor vessel swings over underground sphere which will house it. Dravo Corporation is installing the equipment for AEC-Duquesne Light Co.'s atomic power station



350 separate measurements can be made on a scale model of reactor for Shippingport. Batelle makes tests



Phenomenal city growth presented Memphis with power problem faced by many other U. S. cities today. City plans an 800,000-kw plant to produce power at the same rate as TVA

Memphis Plans Big Power Program

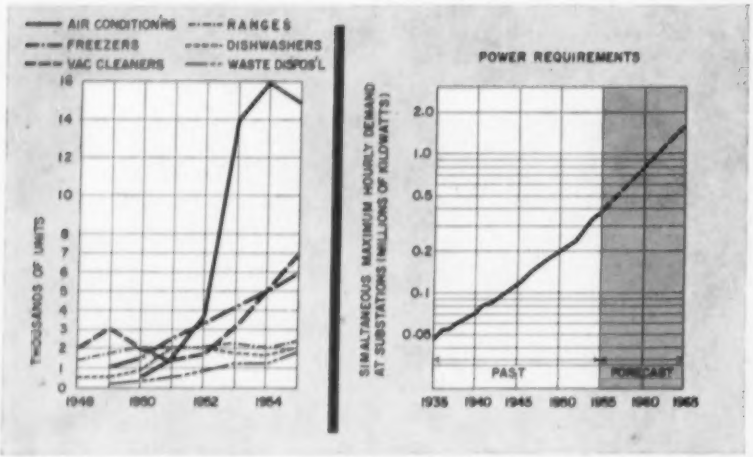


Fig. 1, left, and Fig. 2, right, show growth of electric power loads in recent years

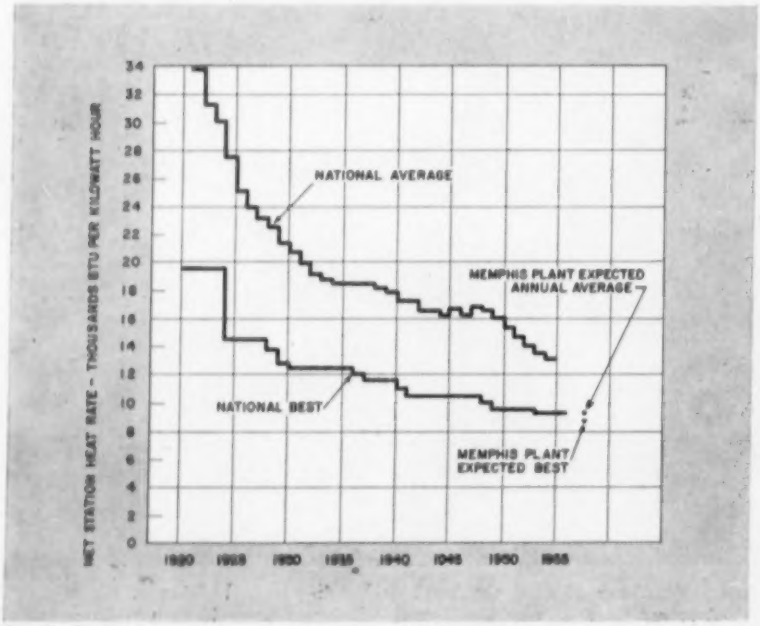


Fig. 3. Chart shows that heat rate of new station will be among lowest in the U. S.

RECENT estimates show that the electrical power industry in this country will have to double its output if the rapidly growing demands of industry and the domestic consumer are to be met.

How these estimates affect the planning of a single city is well shown in the case of Memphis, Tennessee, a fast-growing city with a present population of around 460,000.

To meet growing demands and to attract yet more industry to the area by the promise of cheap and plentiful electric power, the City of Memphis is undertaking a bold expansion program, which they confidently expect will give them ample power at rates as low as those charged by TVA.

The city has disclosed plans to build a power plant financed by an issue of $154,000,000 worth of tax-exempt electric revenue bonds.

This expansion includes a new power plant, which will have three generators, each with a nameplate rating of 250,000 kw, and a total net capability of 812 kw. The first of these units is scheduled to go into operation late in 1958.

Present cost of power purchased by Memphis from TVA is about 4 mills per kwh. Due to rising labor, fuel, and material costs, this value is expected to increase to an estimated 4.4 mills per kwh by 1962. Memphis expects to generate its own power for this figure by 1962.

Before deciding on this plan, a feasibility study was made by Burns and Roe, Inc of New York, and their report formed the basis for the plan now being put into operation.

The charts shown on this page give some idea of the problems faced by the city. Figure 1 shows the steady increase in electric appliance use in recent years, with the extremely rapid increase of such items as air conditioners. Figure 2 shows the steady and rapid increase of load expected in the next few years, and Fig. 3 shows that the new Memphis station will be among the most efficient in the country.

APC in March Will Spotlight Power Engineering Progress

At Hotel Sherman, Chicago, Ill., March 27, 28, 29, American Power Conference will hold its 19th Annual Meeting. Technical sessions will cover latest developments in atomic, supercritical and industrial power plants, fuels, heat balance, electric transmission and distribution.

ADVANCES in atomic power development in the United States and abroad will be described by one of this country's foremost nuclear scientists at the 19th annual American Power Conference in Chicago March 27–29 next.

Presenting a Comparison of American and Foreign Technology in Peacetime Development of the Atom for Power will be Dr. Walter H. Zinn, former director of Argonne National Laboratory at Lemont, Ill.

Zinn, currently president of General Nuclear Engineering Co of Dunedin, Fla., will address the opening general session of the conference, which will be held at the Hotel Sherman.

Conference is sponsored by Illinois Institute of Technology in coöperation with 14 universities and nine national and regional technical societies. As we have pointed out many times, this is the only national conference devoted solely to the problems of the power engineer.

This three-day program will include 25 technical sessions, an All Engineers dinner on March 28, and three luncheon meetings.

More than 3,000 executives, scientists, engineers, educators, and government officials are expected to attend, according to Conference Director R. A. Budenholzer, professor of mechanical engineering at Illinois Tech.

Speaker at the dinner, which is expected to be attended by 1,200 people, will be Gwilym A. Price, president of Westinghouse Electric Corp.

The luncheon speaker on Mar. 27 will be Donald S. Kennedy, president of Edison Electric Institute and of Oklahoma Gas and Electric Co.

The March 29 luncheon will be addressed by Gordon M. Freeman, president of the International Brotherhood of Electrical Workers. The March 28 luncheon speaker will be announced later, Budenholzer stated.

Feature of the 1957 conference will be an evening symposium on March 27 on training and utilization of technical manpower.

Highlight of the technical sessions will be discussions of high-temperature, high-pressure power plants and high-voltage transmission by speakers from England, France, and Switzerland.

One or more sessions will be devoted to each of a wide variety of subjects, including home heating with electricity, use of heat pumps and solar energy for home heating, nuclear energy, hydroelectric power, fuels, gas turbines, use of electronic computing techniques in solving mechanical problems of electric power plants including heat balances, and electric power transmission and generation. About 85 papers will be presented.

Fig. 2. Speaker at an APC fuel session

All Conference papers are later printed in a bound volume of proceedings for each year. These are available to all engineers registering at the Conference.

Universities coöperating with Illinois Tech in sponsoring the conference are: Michigan State, Northwestern, Purdue, Iowa, Iowa State, Illinois, Michigan, Minnesota, Wisconsin, New York, Texas A. & M., California Tech, Georgia Tech, and Massachusetts Institute of Technology.

Coöperating technical societies are: American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Civil Engineers, American Society of Heating and Air Conditioning Engineers, American Society of Mechanical Engineers, National Association of Power Engineers, Western Society of Engineers, and Engineers' Society of Milwaukee.

Inquiries concerning the conference should be addressed to E. R. Whitehead, Secretary, American Power Conference, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Illinois.

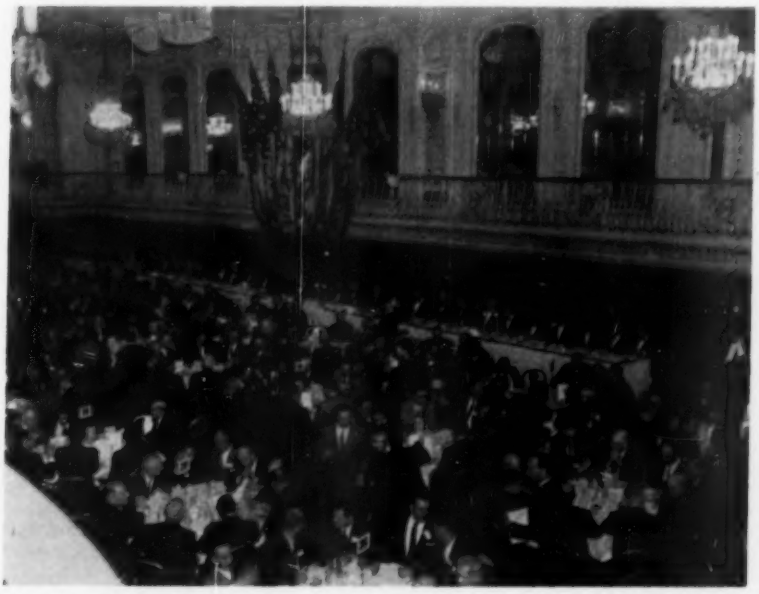
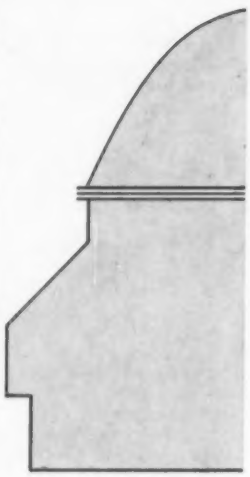


Fig. 1. Typical APC Luncheon meeting during previous conference at Hotel Sherman

How To Check Condensate System

Third of a series on the duties of a start-up engineer in newly-constructed power plants, this article deals with methods of cleaning condensate system prior to operation. Here, condensate system is considered to begin at the turbine exhaust flange, and end at last heater outlet before the deaerator



HERE IS the third of a group of related articles covering the various operations necessary to get a new steam-electric power station ready for commercial operation.

The author is an expert in start-ups; that's his principal job He is writing on the following steps required to start up a new plant:

Cleaning of Auxiliary Piping • Inspecting, Cleaning and Testing of Tanks, Condenser and Feed Water Heaters • Running-in Rotating Equipment • Cleaning the Boiler Feed Water System • Sore Spots to Avoid in the Circulating Water System • Checking, Testing and Pre-setting Instrumentation and Controls • The Boiler: A. Hydrostatic Test; B. Boil out and Acid Wash; C. Setting Relief Valves • Blowing Steam Lines • The Turbine: A. Hydrostatic Test of Hydrogen and Lube Oil Coolers; B. Air Test of Hydrogen Cooling System; C. Oil Flush • Preliminary Operation.

Both the author and the editors welcome your comments on this series and on the individual articles as they appear. The author began this series while Power Engineer with United Engineers & Constructors, Inc. He is now with The Kuljian Corp. as Resident Engineer in Charge of Power Plant Initial Operation in Venezuela where the firm has engineered and built a new plant for C. A. La Electricidad de Caracas.

By J. H. HUNNICUTT *

CONDENSATE SYSTEM will be considered as beginning at the turbine exhaust flange and include the condenser, condensate pumps, air ejector and all extraction steam heaters in the cycle up to, but not including the deaerator, together with all interconnecting piping, valves, and controls. For pipe cleaning purposes, the condensate system will be considered as ending at the outlet of the heater just ahead of the deaerator; if this is a welded connection, the construction forces should be requested to defer making this weld until the system has been cleaned.

Condenser should be thoroughly flushed from a point above the tube bundle with sufficient water pressure to dislodge any small bits of wood, paper, and other debris from the tubes and carry them down into the condenser hot-well where they may be removed by manual cleaning. This is most easily accomplished by introducing water hoses through an open manhole in the turbine exhaust casing.

During this flushing operation, level of flushing water falling through to the hot-well should not be allowed to build up but should be drained to the sewer through an open inspection door or a suitable piping connection.

When the flushing operation is completed, the hot-well should be cleaned, with particular attention being given to removal of welding-rod stubs and other bits of metal which might damage pump impellers. After this has been accomplished, the entire steam side of the condenser should be carefully inspected for cleanliness and closed up, ready for the condenser flood test.

Before proceeding with this operation, the supporting jacks under the four corners of the condenser are run up snugly against their support pads so that the weight of the water to be introduced into the condenser will be on the jacks rather than on the turbine and condenser flanges.

Flood Testing Condenser

Purpose of the condenser flood test is two-fold. First, it must be conclusively established that the flanged connection between the turbine exhaust trunk and the condenser is absolutely tight; otherwise it will be impossible to raise and maintain a vacuum on the system when the unit goes into operation. Second, the condenser tubes and tube sheets must be proved water-tight as a unit; if they are not, circulating water will leak through and it will be impossible to maintain the required condensate purity when the unit is operating.

With the supporting jacks in position, fill the condenser with clean water until the level rises approximately one ft above the flanged connection between turbine and condenser. Care should be exercised that water does not flow over into the turbine casing. If, after allowing the water to remain at a level above the flange for an hour, the outside of the connection remains dry it may be concluded that the flange is tight and will support a vacuum. Drain the water from the condenser until the level falls to a point approximately 12 in. above the condenser tube bundle.

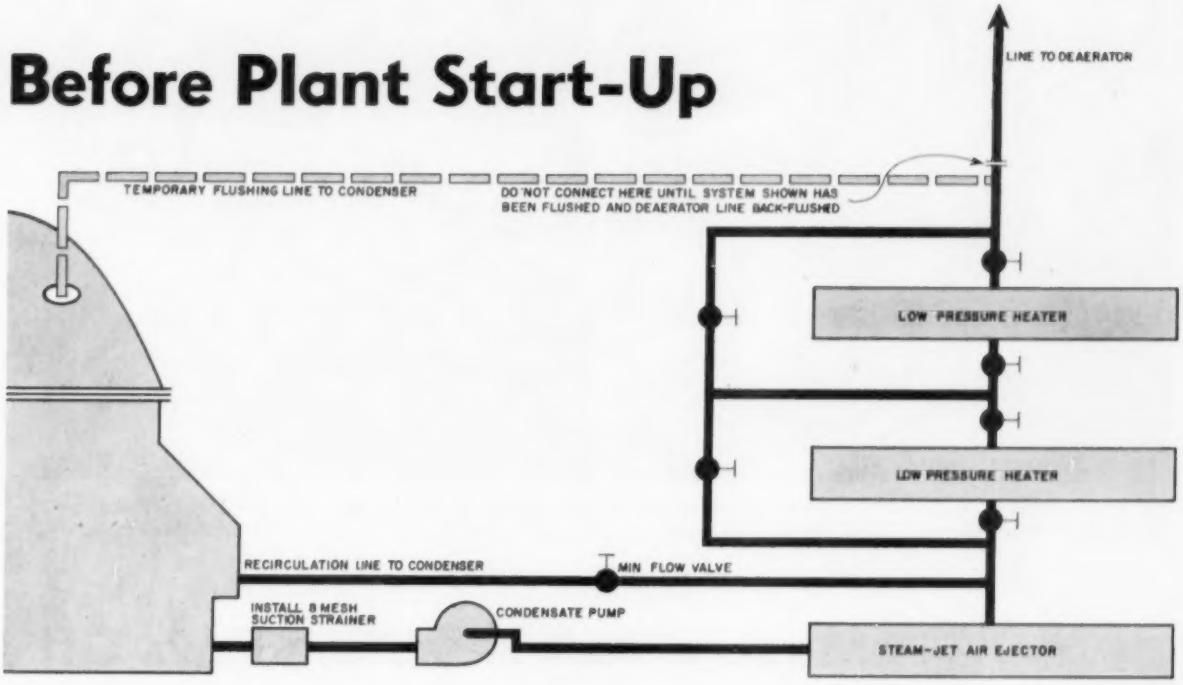
At this point, a phosphorescent dye should be added to the water, thoroughly mixed, and allowed to remain for approximately twelve hours. Numerous such dye preparations are available commercially. They should be dissolved according to the manufacturer's recommendations and the solution added to the water in the condenser. Agitation to assure complete dispersal throughout the condenser can be attained by connecting an air hose to one of the hot-well fittings and permitting compressed air to blow through.

After twelve hours, the outer tube sheet surfaces are to be inspected under strobe or "black" light. Leaks will be readily apparent in the form of luminous stains around the faultily rolled tube connections and these should be marked for re-rolling. When tube sheets have been proved tight, drain and flush the condenser.

In the not very distant past, a simple once-through flushing operation sufficed as a cleaning program for condensate and boiler feed water piping. With the advent of higher

* Project Supt., The Kuljian Corp., Caracas, Venezuela.

Before Plant Start-Up


LINE TO DEAERATOR
TEMPORARY FLUSHING LINE TO CONDENSER
DO NOT CONNECT HERE UNTIL SYSTEM SHOWN HAS BEEN FLUSHED AND DEAERATOR LINE BACK-FLUSHED
LOW PRESSURE HEATER
LOW PRESSURE HEATER
RECIRCULATION LINE TO CONDENSER
MIN FLOW VALVE
INSTALL 8 MESH SUCTION STRAINER
CONDENSATE PUMP
STEAM-JET AIR EJECTOR

boiler pressures, however, the additional factor of silica concentration in boiler feed water became a problem and the practice of limiting boiler pressures to 950 psi until silica concentrations were reduced to below 5 ppm through blowdown became more or less standard. This had the effect of drastically limiting the output of new generating units for as long as two weeks after the unit went on the line due to the heavy concentrations of silica picked up from otherwise clean condensate and boiler feed piping. The advantages to be derived from a more effective pre-operation cleaning of these systems immediately became apparent.

The following method has proved very effective in reducing ultimate silica concentrations in boiler water during the preliminary operations phase; although a certain amount of additional time and effort is involved, certainly these are far outweighed by the obvious advantages to be gained.

Install cone-type wire-mesh strainers in condensate suction lines at the most convenient points between the hot-well and the pump inlets. This generally will be found to be at the expansion joint flanges.

With supporting jacks under the condenser still in position, fill the condenser to a point above the top row of tubes with condensate or demineralized water, if available; otherwise, use the cleanest, purest water to be had.

While the condenser is filling, add sufficient dissolved tri-sodium-phosphate to raise the ultimate phosphate content of the water up to 80 or 100 ppm. Adjust the ultimate pH of the water to 11.0, using caustic soda. It is assumed that at this point the condensate pump motors have been bumped for correct rotation, and that coupling halves between pumps and motors have been checked for alignment and made up. Valve the condensate pump discharge piping so that water will discharge through the air ejector equipment and recirculation line back to the condenser without entering the lowest pressure feed water heater. Start one condensate pump and establish circulation through this portion of the condensate system.

Watch for Vibration

In addition to cleaning the piping, this will also serve as the run-in period for the condensate pumps and a close watch should be maintained to see that they function properly and without undue vibration or heating of the driving motors. Alternate the pumps frequently at the beginning of this operation to permit cleaning of suction strainers until their condition indicates that the interval between cleanings may be extended. Continue this recirculation for at least four hours.

While the above is going on, pipe fitters should run a temporary pipe from the outlet of the last feed water heater in the condensate cycle (i.e., the heater just before deaerator in the feed cycle) to the open manhole in the turbine exhaust casing. The outlet end of this temporary pipe is to be pointed down and away to prevent water splashing back into the turbine. Line up the system to allow the condensate pump discharge to circulate through the by-pass piping and, through the temporary pipe, back to the condenser.

By-pass piping should be thoroughly flushed before putting water through the heaters so that any foreign matter in this piping will be carried back to the condenser where it can be easily removed, rather than into the heaters where subsequent manual cleaning is all but impossible. Finally, route the water through the heaters and continue flushing until at least four hours of trouble-free operation has been attained for each condensate pump.

After flushing is completed, drain the system and again inspect the condenser hot-well. As a rule, additional amounts of welding stub and bead, as well as other debris, will be found to have accumulated and will be cleaned out. Remove, clean, and replace the condensate pump suction strainers.

The temporary pipe may now be removed, but welding of the pipe from the heater to the deaerator should still be deferred until the deaerator has been cleaned, inspected, and flooded to back-flush this particular line.

Fig. 1. New Milliken Station of New York State Electric and Gas Corp installs bottom ash and fly ash removal system

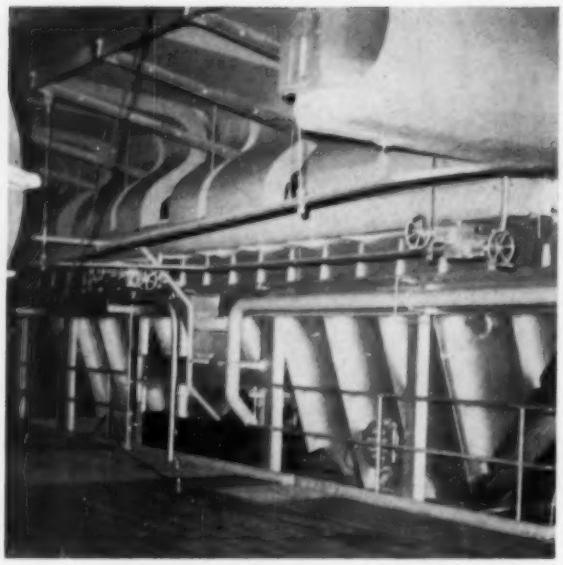


Fig. 2. Dual hopper, located under the 1,000,000-lb-per-hr boiler, collects ash as it is discharged from the furnace bottom

Modern Ash Handling Pays Off At Milliken Station

Great aid in preventing air and stream pollution, increasing plant efficiency, cutting operation and maintenance costs, is modern bottom ash and fly ash removal system on 1,000,000-lb-per-hr boiler at the Milliken Station of the New York State Electric & Gas Corp

By L. E. MYLTING *

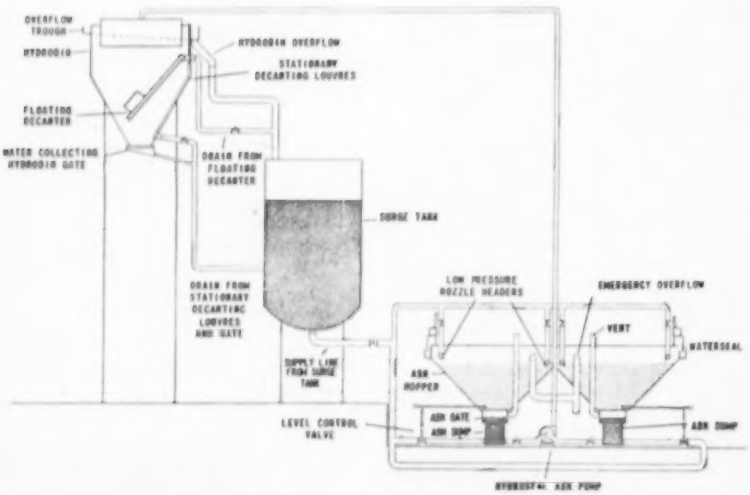


Fig. 5. This schematic drawing of the hydraulic bottom ash system shows equipment involved and illustrates conditions just prior to handling ash as described in text

TO KEEP PACE with a booming U. S. economy, utilities have built numerous new generating plants during the past ten years. This ever-increasing demand for power has also led the industry to concentrate on increasing plant efficiency.

Plants have called for larger and more modern boilers and related equipment. Results are impressive. With up-to-date coal burning equipment, these plants are able to produce from 10 to 40 per cent more steam per dollar of investment.

To achieve the highest possible efficiency, a plant must also solve many problems connected with auxiliaries, including inherently difficult ones — handling problems connected with delivery of coal to boilers and removal of ash. Utilities are using more and more automatic coal and ash handling systems matched to the combustion capacity of their plants.

Study of these systems reveals how this modern, automatic equipment depends less and less on operators. A good example is the ash removal system recently installed by the author's company in the Milliken Station of the New York State Electric and Gas Co., Fig. 1. The power plant was designed by Gilbert Associates of Reading, Penna.

This installation includes both bottom ash and fly ash removal systems. Bottom ash is handled hydraulically

*Vice President in Charge of Engineering, The Allen-Sherman-Hoff Co

Fig. 3. Hydrobin, located in front of the tall dust silo of the fly ash system, overflows into the surge tank shown at right

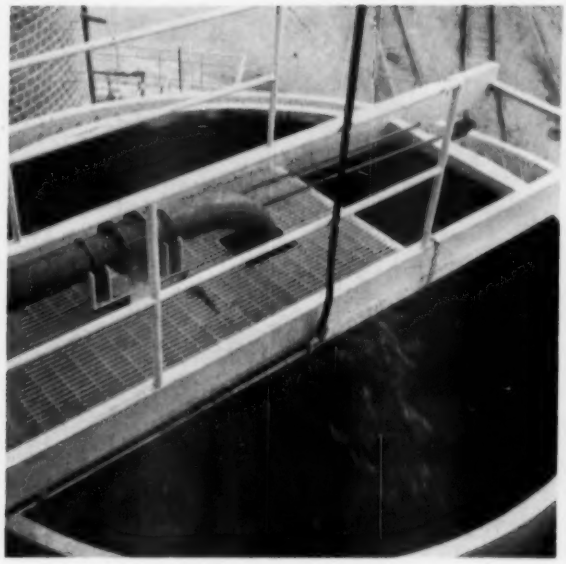


Fig. 4. Ash-laden water is discharged into the top of the Hydrobin and starts to build up in cone-shaped bottom

and fly ash is handled pneumatically. These systems minimize possibilities of air and stream pollution and provide highly efficient automatic operation.

The pneumatic system utilizes primary and secondary collectors for the separation of ash from the conveying air. Operation is made automatic by the use of an automatic sequence control.

Of particular interest is the hydraulic materials handling system for removing furnace bottom ash, to be described here. From start to finish, ash is removed quickly and efficiently by a low-pressure, recirculating system which serves the 1,000,000-lb-per-hr boiler.

A single ash pump serves the entire system, and with no high-pressure water used anywhere, cost of installed horsepower, power consumption and maintenance expense are low. Maintenance is particularly reduced, for the low pressure eliminates high velocities through nozzles and pump clearances and simplifies the packing problems, particularly in valves.

Conveying water is recirculated and re-used, thus contamination of nearby streams is completely eliminated. Practically no make-up water is required in the bottom ash handling system. The only water that enters the system is (a) the clear sealing water for the Hydroseal pump and (b) the make-up water required to compensate for evaporation and water absorbed in the ash.

As shown in Fig. 5, the installation consists of a dual-bottom ash hopper, ash gates, clinker grinders, ash sumps, a Hydroseal ash pump, a Hydrobin, a surge tank, abrasion-resistant piping and appropriate valving and controls.

The dual hopper, Fig. 2, is of heavy steel plate construction, designed to hold a head of water. It is divided into two compartments. The walls of each compartment are sloped to facilitate the gravity feeding of ash. Each compartment can be shut off from the transporting system by means of an ash gate.

Located beneath the gates are double-roll clinker grinders and ash sumps. Valves and spun alloy Ashcolite piping connect the Hydroseal pumps to the sumps. Low-pressure nozzle headers located in each ash hopper compartment are used to flush ashes into the transport system.

The Hydrobin, shown in Fig. 3, is a 100-ton capacity dehydrating ash storage bin equipped with underflow and overflow baffles to separate the ash from the water. Four stationary decanting units are evenly spaced down the sloping sides of the Hydrobin. A floating decanter unit, which rests just below the surface of the water, removes the excess surface water down to the level of the ash within the bin.

The surge tank receives all overflow and decanting water from the Hydrobin. Because of its elevation,

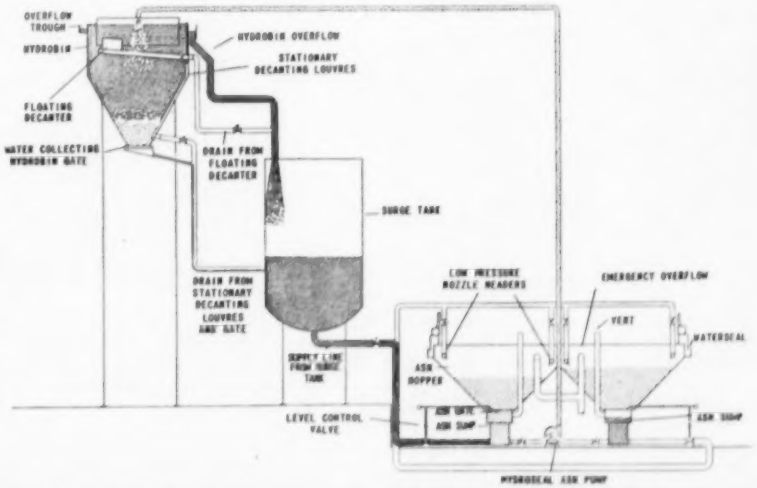


Fig. 6. Discharging ash falls to bottom of Hydrobin while excess water automatically flows over weir and drains into the surge tank, as described in text

Fig. 7. Overflowing water at top of Hydrobin passes under circular underflow baffle and over serrated weir. Floating decanter contains overflow pipe as shown in Fig. 6. Bin also contains stationary decanting louvers with drains

Fig. 8. Excess water in Hydrobin overflow trough passes through overflow piping into this surge tank, and then back through system. Water is slightly muddy and contains fines in suspension, which aids in transporting the ash and pyrites

this tank provides enough head to supply required quantities of low pressure water at both (a) the nozzle headers in the ash hopper (to aid the flow of ash down the interior walls of the hopper) and (b) the inlet to the ash sump (to satisfy pumping conditions).

Operation of System

Here's a step-by-step description of how the bottom ash handling system works: The system is inoperative while bottom ash accumulates in the hopper compartments below the boiler. Figure 5 shows the hopper full of ash, the Hydrobin empty and the surge tank charged with water ready for use. Ash is removed separately from each hopper compartment.

First step in the process is the starting of the Hydroseal pump. This initiates the flow of water from the surge tank through the left-hand ash sump, the pump and the discharge line to the top of the Hydrobin. During this initial phase of the operation, the ash gates are closed and the grinders are not yet in operation.

Next, the clinker grinder is started. This sizes the material for proper internal clearance within the piping, and aids in feeding the material into the system at a uniform rate. After the grinder is operating, the ash gate is opened, allowing material to flow into the enclosed system.

Automatic Overload Control

If there should be a surge of fine material from the ash hopper into the system, the specific gravity of the solution being pumped would increase appreciably. This immediately increases the discharge head of the pump. By means of a pressure switch at the discharge of the pump, the grinder is momentarily stopped to retard the flow of material until the discharge pressure of the pump decreases back to its normal operating pressure. In this manner, overloading the system is automatically prevented.

The Hydroseal pump discharges ash-laden water through about 250 ft of 6-in. diameter Ashcolite piping at a rate of approximately 1000 gpm. This results in a velocity sufficient to keep the solids in suspension.

Ash-laden water is discharged into the top of the Hydrobin, as shown in Fig. 4, and starts to build up in the cone-shaped bottom of the bin, Fig. 6. As the Hydrobin fills with ash, the effluent flows over the weir shown in Fig. 7, and returns to the surge tank, as in Fig. 6. When the hopper has been emptied as far as possible by gravity flow methods, the residual ash is washed into the sump by the low-pressure nozzle headers at the upper end of the slopes and, shortly thereafter, the left-hand hopper is completely emptied. The same operation is repeated for the right-hand hopper compartment. When both compartments are empty, and the system is purged, the pump is stopped.

When the overflow at the top of the Hydrobin stops, the water is decanted through the overflow pipe in the floating decanter. This continues until the decanter can no longer siphon off any more water from the top of the Hydrobin. The final stage of decanting is accomplished by draining off the remaining water through louvers along the sides of the Hydrobin and returning it to the surge tank. At this point, the Hydrobin is ready for unloading.

Also Handles Pyrites

It is interesting to note that pyrites from four pulverizing mills are conveyed pneumatically to an overhead collecting bin. This collecting bin has sufficient storage for periodic removal of the pyrites from the mills. The pyrites are discharged dry by gravity into the ash hopper. In this manner, no outside water is introduced into the system since the material is separated by centrifugal separators from the conveying air in the same manner as the fly ash at this plant is handled.

"What!! You forgot to order the coal?"

Fig. 1. Blocks of dry ice from snow presses, left, travel on conveyor belt to band saw, background, for cutting

How Ammonia Compressors Can Make Dry Ice

CARBON-DIOXIDE gas from natural wells in southeastern Colorado is being changed to dry ice (up to 50 tons per day) at a plant 32 miles from Las Animas. Unusual feature of this plant is the use of a system which utilizes standard Frick Company ammonia compressors in processing the carbon dioxide.

Usual method of making dry ice required that the gas be compressed in three stages. Using water-cooled condensers, this process results in final pressures of 900 to 1200 psig, and pressures of such magnitude call for special compressors with crosshead effect and extra-heavy castings. The system now used by the Colorado CO_2 Corp. obviates the need for this type of equipment.

Leaving the wells, the gas is pumped by a booster compressor into an 8-in. pipe line, five miles long. Gas entering the plant mixing drum, averages 25 psig. (Temperature in this mixer and exchanger is lowered by cold gases returned by the snow presses, and some entrained moisture is removed by this procedure.)

From the mixer, the CO_2 gas is drawn into a pair of standard 12- by 12-in. two-cylinder enclosed type compressors with hydraulically-operated automatic capacity controls. These compressors discharge the gas into a water-cooled shell-and-tube vessel which serves as a pre-cooler and oil separator.

Gas Filtered and Liquified

After leaving the pre-cooler and oil separator, the gas is passed through four vertical oil filters and then reduced to liquid form in a shell-and-tube condenser. This vessel is also vertical and liquid ammonia at −28 F is circulated through its tubes. The CO_2 liquified in the condenser is stored in a large receiver.

From the receiver, the liquid CO_2 goes into a single-pass heat exchanger through which blow-back gas from the snow presses is drawn (before it is mixed with the incoming gas from the wells). Blow-back gas temperature is −100 F or colder. The CO_2 condenser, receiver, and sub-coolers are enclosed in an insulated room.

Sub-cooled CO_2 from the single-pass heat exchanger, or sub-cooler, is expanded into the cubical chambers of the snow presses which form the dry-ice blocks.

Each hydraulic snow press has a chamber 20-in. square, is fitted with a ram in the upper part and a power-operated cover plate at the bottom. The presses have a 24-hr capacity of 25 tons of dry ice.

Compressed CO_2 Flashed to Snow

Liquid CO_2 is expanded into the press chamber at a fixed pressure for a given time; about 42.5 per cent flashes into loose snow. The snow is then compressed by lowering the ram, and the flash gas, about 55 per cent of the charge, is returned to the system as described previously. This process is continued until the compressed block of snow is about 11 inches deep; it is then ejected to a conveyor belt to be fed to the band-saws for final cutting to cube sizes.

The ammonia system includes two 14- by 12-in. four-cylinder compressors which handle suction gas from the CO_2 condensers. The ammonia is condensed in an 8-pass shell-and-tube vessel supplied with water from a cooling tower. Liquid ammonia drains into a receiver fitted with an electronic purger.

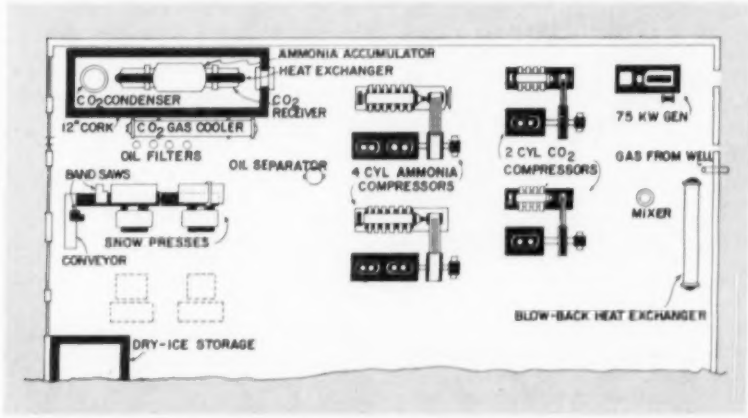


Fig. 2. Equipment layout in machine room of Colorado CO_2 Corp., Las Animas

Illustrations courtesy of Frick Co.

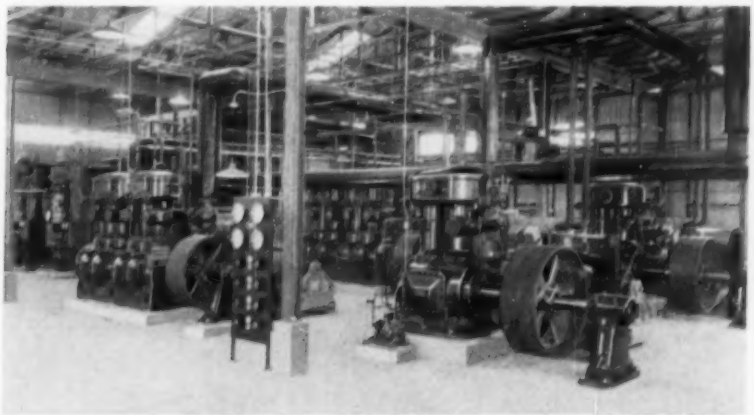


Fig. 3. General view of equipment; ammonia compressors, left; CO_2 units at right

Hot-Lime-Zeolite Still a Good Process

WITH multibed and mixed-bed demineralization receiving so much publicity in recent years, there is a tendency for many engineers to feel that the old hot-lime-zeolite process is obsolescent. A timely ASME Paper, (No. 56-A-191), by S. B. Applebaum and R. J. Zumbrunnen restores the right perspective by pointing out that for many applications the hot-lime-zeolite is perfectly adequate and that there is a large range of medium pressure boilers for which the hot-lime-zeolite process should be compared with demineralization before a decision can be reached to solve a specific boiler problem.

The authors quoted the specific case of the Scott Paper Co at Everett, Wash., which had a boiler-tube problem in 1954, on relatively soft water using internal treatment.

It was decided that silica in the feedwater must be reduced by external water treatment. At first, demineralization only was considered. However, the investment that would be required, and estimated costs of demineralization, were found to be so high that a detailed comparative study was made of all available methods for removing silica. Finally a hot-lime-zeolite system was selected and installed and has been operating with satisfactory results.

The choice between the two systems depends largely on the importance to the particular plant of silica deposits. As is well known, silica deposits in boilers and on steam turbine blades cause serious losses by decreased efficiency and costly maintenance. The only remedy thus far found has been to reduce silica in the steam to lower and lower amounts, and 0.02 ppm has been generally accepted as the maximum tolerance of silica in steam to avoid such deposits.

Now the amount of silica in the steam is a function of boiler pressure and the silica in the boiler water (boiler salines), and Table 1 shows these relationships for pressures from 250 to 3000 psig.

It is obvious from this table that, as boiler pressures rise above 1250 psi, requiring silica content in the boiler of under 3 ppm, demineralization is the only chemical method that can be used. Demineralizers can reduce SiO_2 in the make-up to 0.01 to 0.05 ppm. However, for medium boiler pressures with allowable silica limits of over 5 to 25 ppm in the boiler saline, the effluent make-up silica of 0.5–1–0 ppm from the hot-lime-zeolite process will likewise result in few concentrations and low blowoff and is therefore, entirely suitable.

The dividing line between medium and high-pressure boilers for which demineralization should be compared with other systems usually falls between 750 and 1250 psi.

Demineralized water is undoubtedly superior, having lower total dissolved solids and particularly lower silica, and is definitely the correct treatment for higher pressure boilers. However, hot-lime-zeolite produces water of 0–2 ppm hardness, 20–30 ppm alkalinity, and 0.5–1.0 ppm silica, which will protect medium-pressure boilers and turbines from carry-over, scale, and silica deposits with reasonably low boiler blowoff rates.

Table I. Relation between boiler pressure and silica in water shows how boiler salines are a function of pressure

Boiler Pressure in psig	Ratio of SiO_2 (steam) / SiO_2 (boiler water) Expressed in %	SiO_2 tolerances in ppm in boiler water
250	0.015	100 to 133
500	0.03	50 to 67
750	0.08	19 to 25
1000	0.2	7.5 to 10
1250	0.4	3.8 to 5
1500	0.7	2.1 to 2.9
2000	1.8	0.8 to 1.1
2500	4.5	0.3 to 0.5
3000	16	0.09 to 0.13

Table II. Comparative operating chemical costs and equipment costs for three different methods of water treatment

Demineralizer Chemical	lb/1000 gal	C/lb	C/1000 gal
H_2SO_4	0.39	0.75	0.3
NaOH	1.25	3.00	3.7
			4.0
Salt Splitter			
NaCl	0.25	0.75	0.2
NaOH	0.50	3.00	1.5
H_2SO_4	0.10	0.75	0.08
			1.78
Hot Lime Zeolite			
Lime	0.17	0.75	0.13
MgO	0.20	4.00	0.80
Salt	0.57	0.75	0.43
			1.36

Equipment Cost (Non-Automatic without freight and installation)

Pre-Clarification	$24,900.
Demineralizer	70,000.*
Na_2Z, Saltsplitter and acid feed	39,500.*
Hot Lime Zeolite	50,000.

* These equipment costs do not include pre-clarification which should be added.

Hot-lime-zeolite has the following advantages when compared to demineralization.

1. It can handle raw waters that are not entirely free from turbidity. Demineralizers require clear water to avoid rapid fouling, which in turn involves additional investment for preclarification equipment preceding the demineralizer.

2. Styrene-cation resin used in hot-zeolite plants has proved very stable at high pH values and temperatures not exceeding 250 F. At higher temperatures there have been cases of some deterioration, although even when that happens its replacement cost is only about one third that of anion resins.

3. On the other hand, strongly basic anion resins have been found to be stable only for exceptionally clear well waters low in organic constituents, and then only when rated quite conservatively.

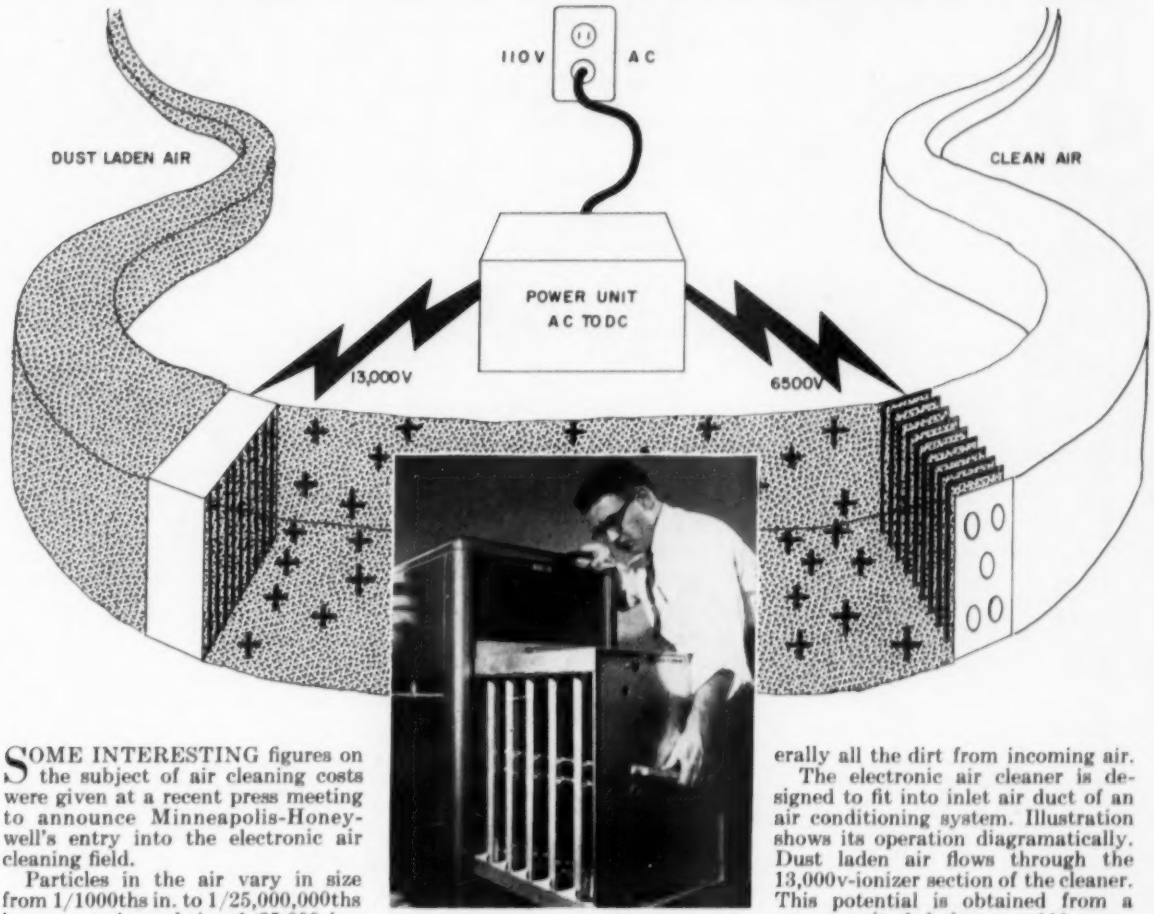
4. Strongly basic anion resins, while doing an excellent job of silica removal, also tend to absorb organic acids, color, iron, and other such impurities. This causes resin fouling. Methods of cleaning resins have been developed, but they are not always successful, and usually only partly restore resin capacity.

5. As the anion resin ages, increases have been observed in the amount of outage and water required for rinsing excess caustic soda to waste before placing the unit back in service after regeneration. When this increase becomes excessive, the anion bed may have to be replaced before the end of its otherwise useful life.

6. Hot-lime-zeolite investment and operating costs are usually much lower. Lime and salt, the chemicals used, are easier to obtain and handle with little fluctuation in cost. Caustic soda used for anion resin regeneration must be of a high grade quality with attendant higher cost.

For all these reasons hot-lime-zeolite should be given careful consideration when the boiler pressure and plant operating conditions made it applicable. One should not assume in advance that demineralization is the only method to use, and a complete study of investment and operating costs should be made to permit selection of the simplest and most economical method of accomplishing the desired results.

Does Your Cleaning Cost Too Much?



Background shows diagramatic operation of electronic air cleaner. Inset photograph shows demonstration model

SOME INTERESTING figures on the subject of air cleaning costs were given at a recent press meeting to announce Minneapolis-Honeywell's entry into the electronic air cleaning field.

Particles in the air vary in size from 1/1000ths in. to 1/25,000,000ths in., or, a micron being 1/25,000 in., from 20 microns to 0.001 micron. The conventional air filter does a fairly good job in trapping the larger particles, but particles below about 5 microns are too small to be removed by these filters. The very small particles, that go right through conventional filters, include smoke, fly ash, rubber particles from tire abrasion, oil mist, bacteria, viruses and many other tiny foreign objects. In terms of cost, at least 50 per cent of the staining caused by dirty air is due to particles smaller than 3 microns, i.e., smaller than can be caught by conventional filtering arrangements. Many engineers with air conditioned buildings do not realize that the air conditioning equipment, with conventional filters, does not clean the air, and as a result all over the country millions of dollars are being spent every year for building cleaning.

In a study of 624 office buildings, it was found that owners spend on the average 57 cents per sq ft to keep the rental space clean enough for occupancy. This represents 23 per cent of the building's entire operating cost. A Minneapolis bank building spends $175,000 a year just for building cleaning, including $12,500 for washing the inside of windows and $10,000 a year for washing walls. None of these figures include such hidden costs as the time spent by stenographers cleaning their typewriters, time lost cleaning ventilating ducts, elevator shafts, control equipment, and all the other places and things that have to be cleaned outside the direct rental areas.

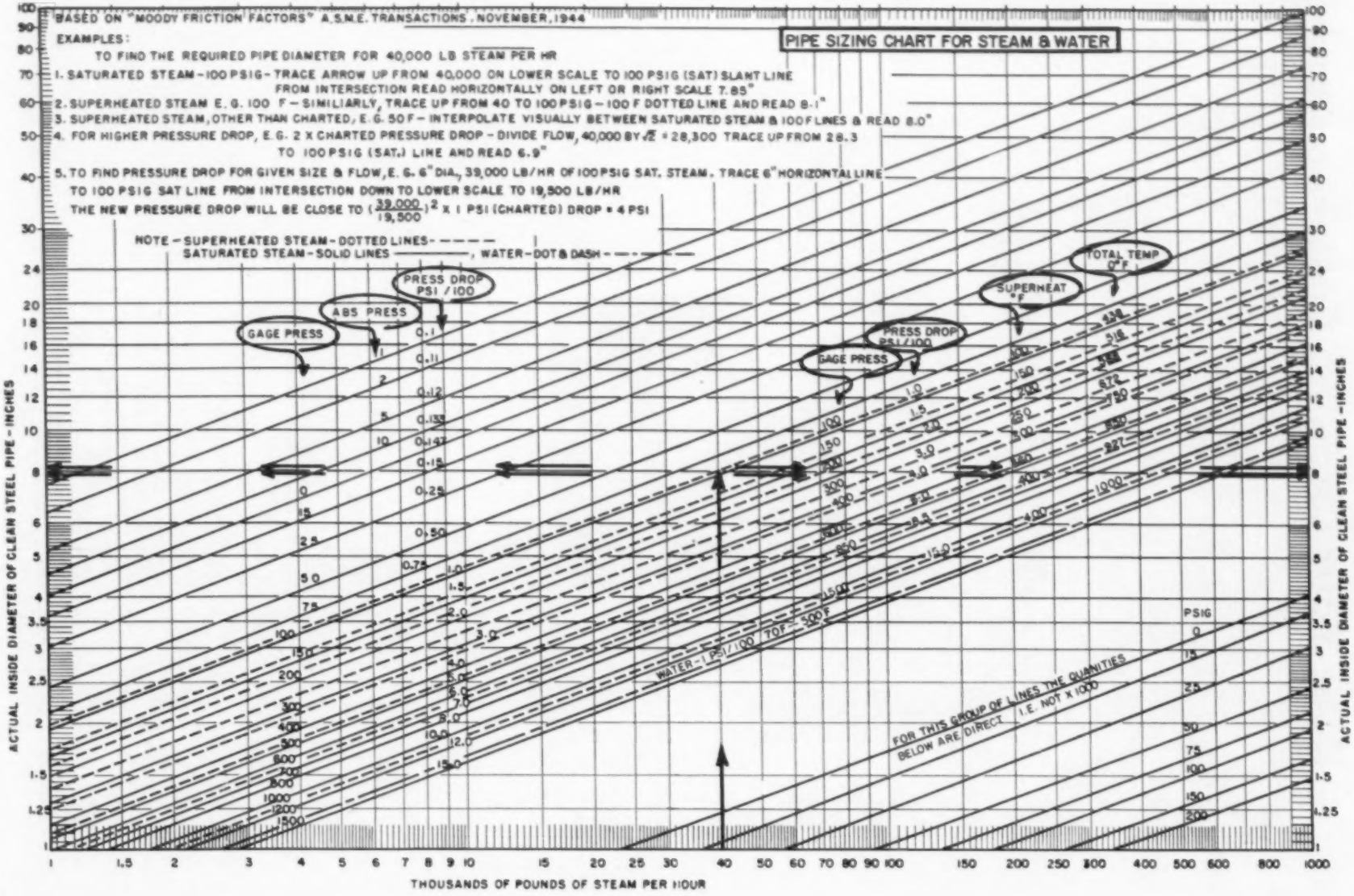
Electronic cleaning, which uses the same principle as the conventional electrostatic precipitator, has the advantage of being able to remove all small particles, down to 1/1000th of a micron. This includes viruses and any known disease-producing germ.

Though the electronic air cleaner is more expensive than the conventional type, when building cleaning costs are added to the initial cost of conventional filters, the electronic cleaner in most cases will come out ahead, since cleaning is unnecessary with a cleaner that can remove literally all the dirt from incoming air.

The electronic air cleaner is designed to fit into inlet air duct of an air conditioning system. Illustration shows its operation diagramatically. Dust laden air flows through the 13,000v-ionizer section of the cleaner. This potential is obtained from a power unit fed from a 110-v a-c source. Passage through the ionizer removes electrons from the dust particle atoms, so they become positively charged ions. These dust ions then pass through a series of collector plates, with a potential of 6500 v between them. The positive ions are attracted to the negative plate and the spare electrons are attracted to the positive plate, while the clean air continues on through the system. When enough dirt has collected on the plates the accumulated dust and dirt is washed away by a water spray.

In addition to the immediate economic advantage of this cleaning system for industrial and office use, it also has enormous future potential for residential units. At present, the air cleaning units cost about $500 apiece installed, but with the reduction in cost that will accompany large-scale manufacture and distribution, it is hoped to bring the cost down to something like $125 or $150 apiece.

Inset photograph illustrates a demonstration model of the electronic air cleaner, showing the ionizing section, and behind it the collector plates.


PIPE SIZING CHART FOR STEAM & WATER
BASED ON "MOODY FRICTION FACTORS" A.S.M.E. TRANSACTIONS, NOVEMBER, 1944
EXAMPLES:
TO FIND THE REQUIRED PIPE DIAMETER FOR 40,000 LB STEAM PER HR
1. SATURATED STEAM - 100 PSIG - TRACE ARROW UP FROM 40,000 ON LOWER SCALE TO 100 PSIG (SAT) SLANT LINE FROM INTERSECTION READ HORIZONTALLY ON LEFT OR RIGHT SCALE 7.85"
2. SUPERHEATED STEAM E. G. 100 F - SIMILIARLY, TRACE UP FROM 40 TO 100 PSIG - 100 F DOTTED LINE AND READ 8-1"
3. SUPERHEATED STEAM, OTHER THAN CHARTED, E. G. 50 F - INTERPOLATE VISUALLY BETWEEN SATURATED STEAM & 100 F LINES & READ 8.0"
4. FOR HIGHER PRESSURE DROP, E. G. 2 X CHARTED PRESSURE DROP - DIVIDE FLOW, 40,000 BY √2 = 28,300 TRACE UP FROM 28.3 TO 100 PSIG (SAT.) LINE AND READ 6.9"
5. TO FIND PRESSURE DROP FOR GIVEN SIZE & FLOW, E. G. 6" DIA., 39,000 LB/HR OF 100 PSIG SAT. STEAM. TRACE 6" HORIZONTAL LINE TO 100 PSIG SAT LINE FROM INTERSECTION DOWN TO LOWER SCALE TO 19,500 LB/HR
THE NEW PRESSURE DROP WILL BE CLOSE TO $(\frac{39,000}{19,500})^2$ X 1 PSI (CHARTED) DROP = 4 PSI
NOTE - SUPERHEATED STEAM - DOTTED LINES - - - - -
SATURATED STEAM - SOLID LINES ———, WATER - DOT & DASH - · - · - ·
GAGE PRESS
ABS PRESS
PRESS DROP PSI / 100
TOTAL TEMP °F
SUPERHEAT °F
WATER - 1 PSI / 100 70F - 500F
FOR THIS GROUP OF LINES THE QUANTITIES BELOW ARE DIRECT I.E. NOT X 1000
PSIG
ACTUAL INSIDE DIAMETER OF CLEAN STEEL PIPE - INCHES
THOUSANDS OF POUNDS OF STEAM PER HOUR

Pipe Sizing Chart—Simple, Accurate

By PAUL R. LUTZ*

PIPE SIZING is an important engineering chore which often has to be done in limited time using methods that are either inaccurate or too complex.

The chart shown on the opposite page is simple to use and gives very accurate results. It has been obtained without compromise of any sort. A very wide flow range is included, i.e. up to 1,000,000 lb per hr, and the chart covers pipes of 1 to 100 in.

Low pressure drops have been chosen to give conservative sizing for quick and reliable use.

The pressure drops are as indicated for saturated steam between 1 psi absolute and 14.7 psi absolute, and for all other pressures, 15 psig and up, the indicated drops are equal to 1 per cent of the gage pressures.

Below atmospheric pressure, the 1 per cent figure gives pressure drops too small to be practical, so the values on the chart in the column headed Pressure Drop (psig/100) have been taken from practical experience for pressures below zero gage pressure. Readers using the chart for these low pressures may use their own values for pressure drop if they prefer them.

Actual required inside diameter is obtained by starting up from the steam quantity on the lower horizontal base line, to the intersection with a sloping steam pressure line, thence to the pipe size on the left or right of the chart. Due to the low pressure drop basis, the nearest nominal size will often be satisfactory.

Flow with higher pressure drop may be closely estimated from the relation:

$$\sqrt{\frac{\text{Higher drop}}{\text{Charted drop}}} \times \text{charted flow} = \text{Higher flow}$$

Examples:

2 per cent pressure drop instead of 1 per cent charted would mean 1.41 × charted flow.

3 per cent pressure drop instead of 1 per cent charted would mean 1.73 × charted flow.

4 per cent pressure drop instead of 1 per cent charted would mean 2.0 × charted flow.

So, to use the chart to find pipe size with 2:1 pressure drop, for example, first divide required flow by 1.41.

Such results will be highly accurate, well within the limits of the basic data, and slightly conservative with the higher pressure drops, as corresponding friction factors are generally only slightly lower.

Dash lines for superheat give a convenient comparison with the saturated steam line for the same gage pressure, the pressure drop being the same 1 per cent relation.

Velocity curves are not shown for the following reasons:

1. To retain chart simplicity.
2. Knowledge of the velocities within the pressure drop limitations generally serves no useful purpose.
3. The pressure drop is usually the yardstick which applies much more importantly than velocity.

Examples are given on the chart for the several types of problems most commonly needed.

Additional lines for other conditions which the engineer might need repeatedly can be plotted by calculating one, two, or three points depending on refinements required.

Each calculated point was obtained from the Moody Friction Factors for Pipe Flow, in the Nov. 1944 ASME Transactions. Readers interested in the method by which the points on the chart are obtained may write the Editor of POWER ENGINEERING for the mathematical calculations.

*Mechanical Engineer, Day & Zimmerman, Inc.

GE Produces Own Version of TV's "Line-Up"

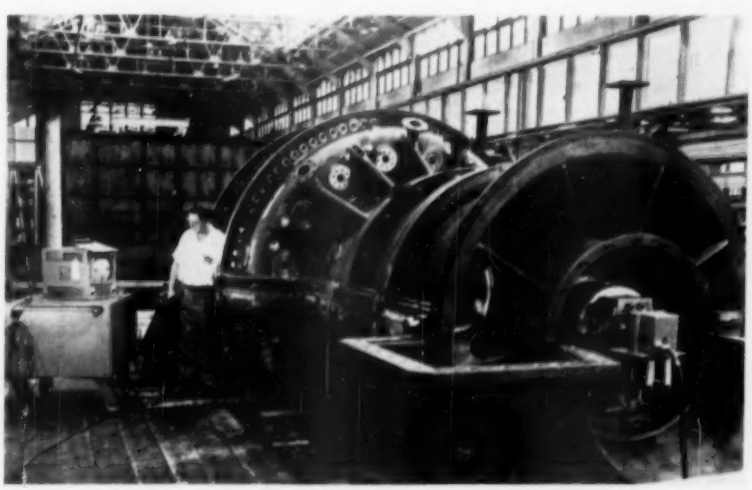
TIME-HONORED METHOD of aligning turbine shells at General Electric's Gas Turbine Department in Schenectady involved use of a taut wire stretched through the housing; with this as the established centerline, alignment of the units was then estimated for assembly purposes.

A faster, more precise method of performing this line-up operation was developed by the company's Technical Products Department. The new method utilizes a special closed-circuit TV system consisting essentially of a camera, connecting cable, and a monitor (receiver).

When lining up the turbine shells, the camera is bolted, leveled, and centered on the first or master shell (shown at extreme right in illustration). When another shell is to be attached, a target plate is centered in the new shell and the camera lens focused to the known distance to the target. Then, by watching the monitor as the new shell is moved into place, an operator can accurately adjust and align this shell with the master shell set up previously.

Especially designed to operate under the rugged conditions and low light levels often found in industrial applications, the camera is equipped with a telescopic lens. The monitor (at left in photo) resembles a home TV receiver, but, because of its 600-line resolution, brings in a picture which is much clearer in detail than that of a home receiver (525-line).

Gas turbine shown is the largest yet to be manufactured in the Western Hemisphere; rated at 16,500 kw, it will be installed in Mexico.



Engineer at GE's Gas Turbine Department lines up units with a special TV set

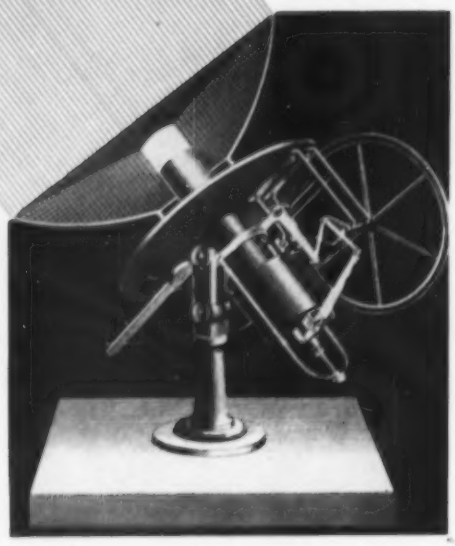


Fig. 1. Ericsson's first solar engine was able to generate a fraction of a hp

Energy From The Sun

In our December 1956 issue the author reviewed the world energy situation and showed why new sources are so necessary for us. Here he discusses availability of solar energy and some devices used to harness it

By JOHN I. YELLOTT*

RADIATION, the fuel† for solar energy, is the radiation which the sun transmits to the earth through some 92,500,000 miles of virtually empty space. Unlike the extremely potent radiation which constitutes the fuel for atomic power plants, solar radiation is diffuse and contains no lethal frequencies. The wavelengths which reach our atmosphere range from the invisibly short ultra-violet (0.25 microns) through the visible (0.4 to 0.8 μ) to the far infrared (20 μ). Of the sun's radiant energy, 99 per cent is contained in the narrow band between 0.25 and 3.0 microns.

The distribution of radiation intensity throughout the solar spectrum tells us that the sun's surface temperature is about 10,000 F. The temperature of the sun's interior, where hydrogen fusion produces the virtually unending conversion from matter to energy, is estimated to be 30,000,000 F!

Solar energy is measured in terms of the heat produced when the radiation falling on a surface is completely absorbed. The unit of radiation measurement (one gram calory per square centimeter) is the langley (ly), named for the great astronomer of the Smithsonian Institution. Converted to more familiar units:

1 ly = 3.687 Btu/ft^2 (Btu per square foot)

1 ly /min = 221.2 Btu/ft^2-hr (Btu per square foot per hour) = 698 watt/meter^2 (watts per square meter)

† Since the term "fuel" has been adopted in nuclear technology for an energy source which is radiant rather than combustive, the same concept may be used in discussing solar energy.

Author's Note: — When the first installment of this series was being prepared, the current crisis in the Middle East was still in the making. The vital importance of the oil supplied from the deserts of Arabia has now become apparent to everyone.

The vast energy reserves which lie beneath Iran, Iraq, Kuwait and Saudi Arabia are the prize for which the industrialized nations of the world are contesting. Political and economic decisions of far-reaching significance are now being made with *energy* as the primary consideration.

Beyond the Atmosphere

The rate at which solar energy reaches the earth's atmosphere is known as the solar constant. The first accurate value was John Ericsson's estimate of 7.11 heat units per min per sq ft (426 Btu/ft^2-hr). Measurements of great precision were made before World War I in many parts of the world by Smithsonian expeditions headed by Dr. C. G. Abbot.[1] He found definite evidence of minor variations in the sun's output, and concluded that a reliable average value was 1.94 ly/min or 429 Btu/ft^2-hr. This value was raised slightly in 1954 by Johnson and again in 1956 by Stair and Johnston[2] after studying data from high altitude rockets and from spectroscopic measurements made at Sun Spot, New Mexico. 2.04 ly/min (451 Btu/ft^2-hr) is now believed to be a good mean value.

The radiant energy which reaches the outer fringes of our atmosphere is materially reduced by scattering and absorption before it reaches the earth's surface. On a clear day, at sea level, the *direct* radiation may range from 250 to 320 Btu/ft^2-hr. The 30 to 40 per cent which is scattered by dust and absorbed by air molecules, water vapor, etc. is not entirely lost, because about half of it reaches the earth as *diffuse* radiation. The total

* Executive Director, Association for Applied Solar Energy.

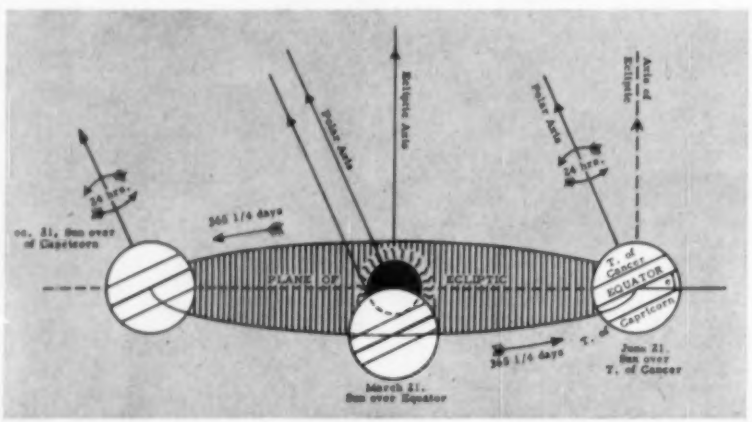


Fig. 2. The slightly elliptical orbit of the earth, as shown above, causes us to be 3.5 per cent farther away from our energy source in summer than in winter

usable solar energy is the sum of these two components. A concentrating collector, such as a solar furnace, can use only the direct radiation which travels in straight lines and can be focussed. A flat plate collector can use both the direct and the diffuse radiation.

The total amount of radiation which reaches a collector on the earth's surface depends upon the number of hours of sunshine per day, and the thickness and nature of the atmospheric path through which the sun's rays must travel. The angle between the collector surface and the rays also determines the amount of energy which can be collected per sq ft of surface. The first two factors depend primarily upon the earth's movements around the sun and local weather, while the arrangement of the collection surface is a matter for the designer to determine.

The earth moves around the sun (Fig. 2) in a slightly elliptical orbit which causes us to be some 3½ per cent farther away from our energy source in summer than in winter. The celestial axis about which our planet rotates daily is not parallel to the axis of the elliptic plane of our orbit and so we are tilted away from the sun in the winter, and towards it in the summer. This 23½ deg tilt means that, in mid-summer, the sun's radiation has a minimum thickness of atmosphere to traverse before reaching the earth's surface. In mid-winter, our part of the globe is tilted away from the sun, and solar radiation must travel through a maximum blanket of air in order to reach us. Horizontal collector surfaces are also more effective in summer than in winter because of the sun's higher position in the sky.

Our tilted axis causes the length of our day to vary with the season. A simple excursion into astronomy tells us how high the sun will rise in the sky on any given date. On the two equinoxes, March 21 and September 21, the sun's noon altitude will be equal to the local latitude plus 23½ deg. Taking Phoenix, Arizona, (latitude 33½ deg N) as an example, the sun's noon altitude on the two equinoxes is 57 deg. By June 21, the sun has moved 23½ deg farther north, and the noon altitude is 80½ deg. On December 21, the sun reaches its most southerly position; the day is only 10 hours long and the noon altitude is only 33½ deg.

Solar Energy Inventory

The U. S. Weather Bureau maintains 58 stations where daily measurements are made of the total solar energy falling on a horizontal flat plate. The direct radiation component is measured at a few other locations and the data are published monthly.[4] These data have been analyzed and correlated to give the type of chart shown in Fig. 4. Average total radiation per summer day in the United States varies from almost 2600 Btu/ft²-day in the arid mountains of the Southwest to 1850 along the coasts from Maine to Florida. In winter, latitude is the most important factor.[5]

A single sq ft of collector surface in Maine or Oregon will receive about 440,000 Btu in a year, while the same sq ft, moved to southern Arizona, would receive nearly 730,000 Btu. Latitude and cloud cover are the two most important factors in determining the total insolation at any particular location.

Most of the inhabited areas of the world receive plenty of solar energy to meet all of man's requirements. The United States, for example, re-

Fig. 3. Somor Solar Pump, which converts the sun's radiant energy into mechanical work. Turntable enables collectors to be turned to the most efficient position

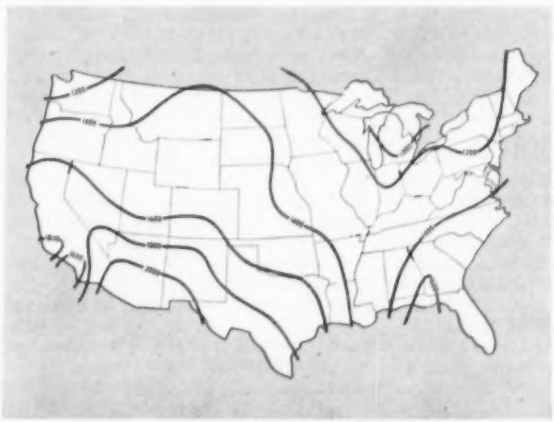


Fig. 4. Distribution of solar energy over the United States. Figures give solar heat in Btu per sq ft per average day

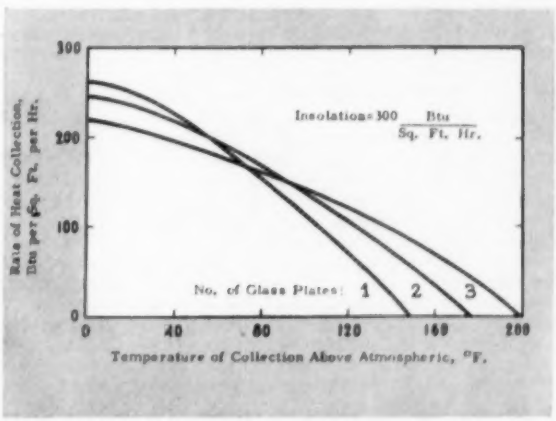


Fig. 5. Chart showing relation between temperature, number of cover plates, and efficiency for a flat plate collector

Fig. 6. Concentrator-type solar plant, constructed in 1901 at Tempe, Arizona, was used for pumping irrigation water

Fig. 7. Experimental model of 400 cell solar energy converter using silicon cells

ceives more than 30,000 x 10^{15} Btu, or 700 times our present energy use. The problem which the engineer must solve is how to use this abundant supply of free *income energy* at a total cost which is within our ability to pay.

Utilization of Solar Energy

The sun's energy manifests itself as thermal, photo-electric and photo-chemical effects. A brief summary will be given of the first two. The third, which includes the most important process of photosynthesis, is beyond the scope of this brief review. Men have tried to use solar energy since earliest times, but no means existed to generate useful power from the sun's heat until steam and hot-air engines were invented. Crude devices to heat water by solar energy date back many years, and production of salt by solar evaporation of sea water is probably the most ancient of man's sun-activated processes. Photo-electricity has been known for almost a century, and millions of selenium photocells have been used as light-meters and in similar applications. The silicon cell, developed within the past two years by scientists of the Bell Laboratories and Hoffman Electronics, is the most efficient way known today to convert sunlight into electricity.

Thermal Applications

Most fundamental of all thermal solar processes is the simple fact that, when sunlight falls upon a surface of any kind, the surface becomes warmer than the surrounding air. The extent to which the surface temperature rises depends upon many factors, most important of which are, a, the angle between the surface and the sun's rays, b, the absorptivity of the surface, and c, the precautions taken to prevent the surface from losing the absorbed heat by convection to the surrounding air, by conduction through its supporting structure, and by radiation back to the sky. A detailed discussion of these factors can be found in references 3, 7, 8, and 9.

The angle effect is caused by the fact that the sun's rays travel in straight lines. When a surface is perpendicular to the rays, their *intensity* is at its maximum, but when the surface is tilted away from the sun, the radiation intensity drops off and reaches its minimum when the surface is horizontal.[3]

The absorptivity of the surface is extremely important, since shiny metallic surfaces reflect most of the incident energy, while dull black surfaces can absorb as much as 96 to 98 per cent. Recently, a type of surface has been developed by H. Tabor of Israel which is highly absorptive for the short wavelength radiation from the sun, but is a very poor emitter of the long wavelengths which come from low temperature surfaces. This selective absorption is a very important discovery and one which deserves greatly intensified research.

The most effective way to minimize the loss of energy from the sun-heated surface is to cover it with one or more sheets of a glass-like material which is transparent to the sun's rays but opaque to the longer wave lengths emitted by the warmed surface. This is the familiar greenhouse effect. The air space between the surface and the glass is an effective preventer of heat loss by convection. The insulating effect is materially improved by evacuating the space.

Flat Plate Collectors

A flat plate of blackened metal, covered with one or more transparent sheets of glass or plastic, is the simplest collector of solar energy. Some means must be found to transport the collected energy to a device which can use it, and this is most readily done by attaching tubing to the surface. A fluid can then be used to carry the heat to the point where it can be used. Recently, two processes have been developed by which the tubes and the sheet are integral, thus greatly reducing the cost of the collector. Plastic cover sheets with the same optical properties as glass, but with much lower cost, are also available now. These two developments will bring about a major reduction in the cost of solar heat collectors.

The temperature at which the energy can be collected is of paramount importance. As this temperature rises, the heat loss from the collector also increases, and the efficiency of collection drops off. Efficiency is important in solar engineering because it controls the first cost of the installation rather than the operating cost as in more conventional fuel-burning equipment. The relation between temperature of collection, number of cover plates, and collection efficiency for a particular configuration [9] is shown in Fig. 5.

A flat plate collector, operating under favorable conditions, can readily maintain its surface temperature at 100 F above the ambient air. Water and air heaters in the southern half of the United States, for example, can operate at 150 F to 160 F outlet temperature without difficulty during most of the year.

Space Heating

Once heat has been collected in the temperature range of 140 to 160 F, it can be used in a variety of ways. Here are some of the potential and actual applications.

Space heating is probably the most important, since nearly one-third of our energy supply is used for this purpose. An excellent example of this application is the heating system recently installed by Bridgers and Paxton in their new Solar Building in Albuquerque, New Mexico.

Here virtually all of the heat required to maintain comfort throughout the winter will be procured by 890 sq ft of aluminum collector surface, covered with single sheets of window glass. Water is used as the working fluid and heat storage is afforded by a 5000 gal tank buried beside the building. A heat pump is used to supply auxiliary heat when four sunless cold days occur in

Fig. 8. Solar energy furnace, with a 5 ft diam parabolic reflector, recently installed at Arizona State College

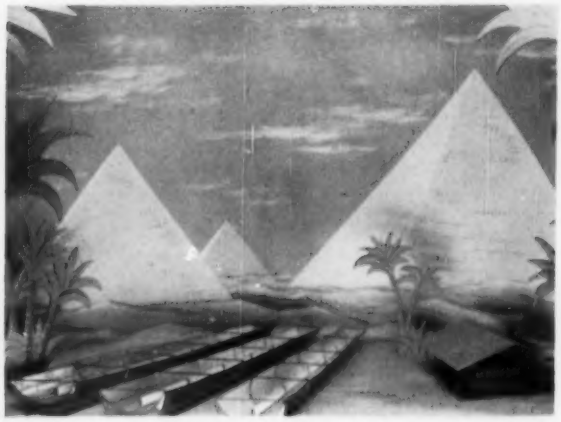


Fig. 9. Artist's version of solar power plant built in Egypt in 1913 with 14 ft wide by 205 ft long parabolic troughs

sequence, and to cool the building in summer. This use of a warm water-to-air heat pump is likely to become increasingly important in the future when electricity will supply most of our domestic energy needs.

The distillation of sea water is another process of great potential significance which can be accomplished by variations of the simple flat plate collector. A single glass or plastic cover above a moistened black fabric provides a very simple heat trap which can produce more than a gallon of distilled water per day for each 10 sq ft of surface.[13] Recent developments of multiple-effect evaporators give promise of multiplying this output by a factor of at least four. Major developments in the solar distillation of sea water should result from a program now under way at San Diego, Calif., under the sponsorship of the Office of Saline Water, U. S. Department of the Interior.

The production of temperatures low enough for air conditioning and domestic refrigeration can be accomplished by absorption systems using ammonia, water, and hydrogen. This is a very important potential use of solar energy which is only now beginning to receive the attention which it deserves. A significant degree of cooling can be accomplished by radiating heat to the night sky and storing the chilled water for use during the heat of the day.

Power in limited quantities can be produced from flat plate collectors by the use of volatile fluids such as SO_2, Freon, etc. One example of this process is the Somor pump, produced in Italy and demonstrated at the Solar Engineering Exhibit in Phoenix in 1955. The vapor is used to operate a small reciprocating engine which drives a pump. The water which is lifted by the pump is used to cool the condenser.

The use of Tabor's selective surface on well-insulated flat plate collectors which track the sun will enable vapor to be generated at respectable pressures from Freon and similar fluids. More efficient solar prime movers will undoubtedly come from this combination.

Concentrating Collectors

Collectors which concentrate sunbeams of large area on relatively small areas can operate at temperatures up to 5000 F. The solar furnaces now used for high temperature research use precise parabolic reflectors to concentrate large amounts of radiation upon small targets. Such furnaces can maintain temperatures above the melting point of any known metal for daily periods up to 8 hrs. Figure 8 shows the 5-ft diam furnace now in use at Arizona State College in Tempe.

Power generation from solar energy has been accomplished many times during the past 100 years. None of the developments described below has been a commercial success, but each has moved a step forward towards a goal which must some day be achieved.

America's first great solar scientist was John Ericsson. The fame and affluence which were his rewards for the victory of the *Monitor* over the *Virginia* enabled him to devote the last 25 years of his life to solar energy. His first operable solar device was the hot air engine shown in Fig. 1. The conical reflector, which concentrated the sun's rays upon the hot end of the single cylinder, collected enough solar energy to permit a fraction of a horsepower to be generated.

Ericsson determined that the conical concentrator could not collect enough energy at the available rate of insolation, 250 to 300 Btu/ft^2-hr, so he turned his attention to the much larger steam engine. The hot air engine was converted into a gas burner, and thousands were sold for water pumping and similar low powered applications.

One type of parabolic trough concentrator used flat silvered glass mirrors to direct the radiation "contained in a sunbeam of 23,400 sq in. cross-section" upon a heater tube 6½ in. in diam and 11 ft long. The resulting 27-fold concentration permitted steam to be generated at 35 psi abs in quantities sufficient to run the 6 in. by 8 in. condensing engine at 120 rpm.

The arrangement shown in Fig. 1 is typical of concentrator-type solar plants. These must be able to track the sun, so that its rays can be focussed upon a collection element. The largest plants erected in the United States were those built shortly after 1900 by A. G. Eneas, an Englishman whose work was financed by a group of Boston investors. Figure 6 shows a photograph taken in 1901 of a plant on the banks of the Salt River at Tempe, Arizona. This collector was rotated at the necessary 15 deg per hour by a weight which was cranked up to the top of the supporting tower each day. The change in the altitude of the reflector was made manually every few days. This plant was used for pumping irrigation water until it was destroyed by a sandstorm in 1903.

Largest Plant in 1913

The largest of all solar power plants was constructed in 1913 at Meadi, Egypt, by Frank Shuman, again with English capital, and with the wise counsel of the British physicist, E. V. Boys. Shown in an artist's version in Fig. 9, this plant used seven parabolic troughs, 14 ft wide at their opening and 205 ft long. The economics of this installation in 1913 were marginal, and the advent of World War I caused it to be abandoned.

Interest in solar power plants has been revived since World War II, primarily as sources of irrigation water and small amounts of electricity.[6] Dr. C. G. Abbot has built several very efficient small steam generators using parabolic concentrators which focussed the sun's energy upon blackened copper pipes contained within evacuated glass tubes. The largest of these is about to be tested at the University of Arizona. *continued on page 114*

Fig. 1. Tube wall thickness being measured by Penetron with tangential head. Thickness is read directly off the meter

Fig. 2. The Penetron, with standard head (shown in section in Fig. 4) being used to measure boiler tube wall thicknesses

Atomic Tool Measures Tube Thickness

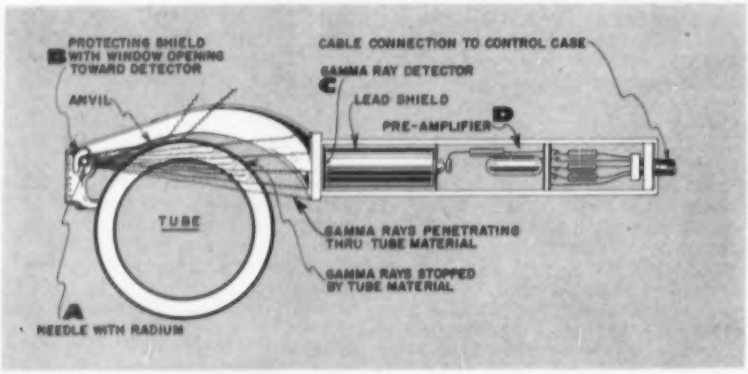


Fig. 3. The Penetron has two types of head. Diagram above shows principle of measuring tube thicknesses with the tangential head. This is the one shown in Fig. 1

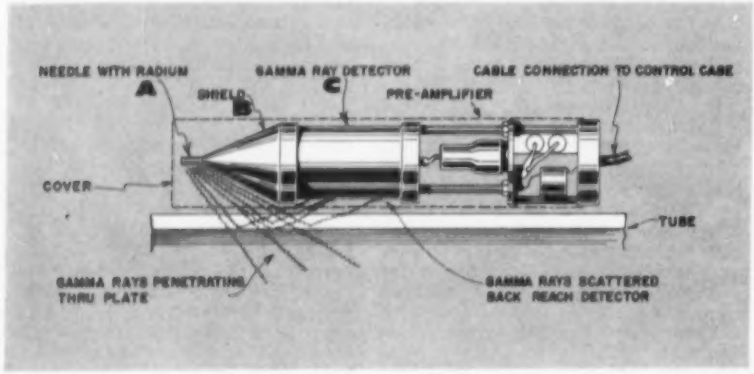


Fig. 4. Shows principle of measuring tube wall thicknesses with Penetron's standard head. Figures 2 and 5 show the Penetron in operation with this type of head

Using the ability of gamma rays to pass through steel, this instrument measures accurately the thickness of boiler and superheater tubing, thus enabling weaknesses to be detected in good time and avoiding the unnecessary removal of good tubing

NOT LONG AGO, one of Detroit Edison's St. Clair Station boilers developed three waterwall leaks. Repairing them was easy enough, but the leaks showed that the tubes were weak in places and more leaks might be expected before long.

Here was a familiar problem. Should the tubes be replaced at once, with the risk of removing many sections of expensive alloy tubing before their useful life had been exhausted, or should they be left, with the risk of having a tube fail at a time when the boiler might be vitally needed?

The Penetron

To the rescue came an atomic device, called the Penetron, which enabled DE's engineers to measure accurately the wall thicknesses of all their suspect tubing. Figures 1, 2, and 5 show this instrument in action, and here is how it works.

The Penetron is made with two types of measuring head. One, the tangential head, is for use on the outside of tubes or pipes. The other, the standard head, can be used on either the inside or outside of a pipe.

Fig. 5. Andre deWilde, Detroit Edison Company Research Engineer, using the Penetron with standard head to measure wall thickness of a large insulated pipe

Let us consider the tangential head first. Figure 3 shows a section through the instrument. A small piece of radium A is located inside a heavy shield B. The shield is for the operator's protection. Through a small window in this shield, gamma rays from the radium radiate toward the detector C passing through the tube on their way. Rays that get through the tube are counted by the detector, this count being sent via the pre-amplifier D to a meter in the control case (shown in Fig. 1). A thick metal tube wall allows fewer rays to get through, giving a lower meter reading. By suitably calibrating the meter, it can be made to read the actual wall thickness of the tube through which the gamma rays are passing. Figure 1 shows the tangential head in use.

Standard Head

Since the bundle of gamma rays emitted by the radium through the shield window covers about 1 sq in., that is the area of the tube wall over which the thickness is measured. Any pipe from 1 to 12½ in. can be checked in this manner.

Figure 4 shows a section through the standard head. A is a radium needle, B a shield, and C the gamma ray detector. In this case, no direct rays from the source reach the detector, but only those rays which are scattered back from the metal whose thickness is being measured. The amount of reflection depends on the thickness of metal. A thick metal will reflect more rays than a thin one. The reflection is done by the entire thickness of metal and not just a layer.

As with the tangential head, the rays arriving at the counter are amplified and passed on to a suitably calibrated meter, which reads the thickness of metal directly. Figures 2 and 5 show the standard head in use.

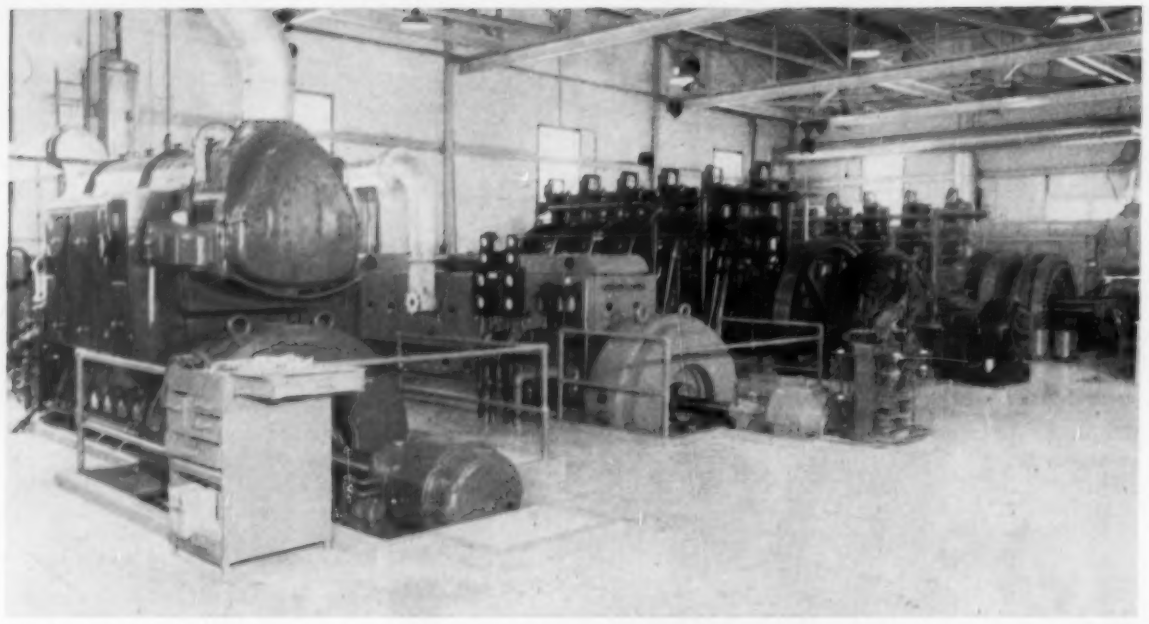
Other Applications

Note the difference in meter readings between application of the two types of head. With the tangential head, the reading decreases with thickness of metal, while the opposite is true for the standard head. However, this makes no difference to the final result, since each instrument is calibrated to read wall thicknesses directly.

This new instrument has many possibilities. To give a couple of examples. It is possible to determine water level in a pipe with it. Water absorbs gamma rays, so if the tangential head is moved up the outside of a tube containing water, the meter reading will change sharply when the water level is passed.

Another application was made recently in Detroit Edison's Research Laboratories, when the weight per cu ft of fly ash was measured under various conditions of compacting by means of the Penetron.

The above information is based on articles by Andre deWilde and Gordon G. Mattox in Detroit Edison's *Coal to Kilowatts.*



Municipal electric light and power plant in New England relies on big diesels, can't gamble on short-cut operating tricks

Cut Maintenance, Increase Diesel Life With Proper Warm-Up Procedure

How you start and apply load to your stationary diesel can have a decided effect on maintenance costs and engine life. Author tells why proper warm-up procedure is necessary and how to go about it

By C. B. GRAVES

LONGER LIFE AND decreased maintenance costs for diesel engines can be achieved simply by following a common-sense procedure in starting and warming up the equipment.

Start and warm-up is the most critical phase of operation for all internal combustion engines and particularly so for the larger units. During this time, engines operate under the most unfavorable conditions to which they are subject in normal service; any steps that can be taken to reduce the effects of these conditions will pay off handsomely by extending engine life significantly.

One of the roughest forms of usage to which a large stationary diesel can be put is to start the engine cold, bring it up to full speed immediately and apply a full load. The reason most often given to explain why this is harmful is that such practice does not permit adequate flow of lubricating oil to bearing surfaces before they are placed under load. While this is quite true, there is an equally important reason why loading a cold engine is bad practice. That reason is the unequal rate at which metal parts in the engine expand as it warms up to operating temperature.

It takes a good deal longer for engine parts to stabilize, expansionwise, than it does for the lube oil system to reach operating efficiency.

How Scuffing Occurs

Consider what happens when cold engine is started and put on load at once: Cylinder heads, pistons, and upper parts of the liners are heated rapidly and attain normal expansion in short order; other parts are still relatively cold and stresses, strains, or actual distortion and misalignment may occur. With some running clearances measuring only a few thousandths of an inch, even slight misalignment may result in cylinder and piston scuffing or wiping of bearings. Where physical clearances are eliminated entirely by distortion, lubricants cannot prevent metal-to-metal contact and resultant damage.

In some cases, because of forced warm-up, engine frames or bedplates may heat much faster on one side or the other and throw the crankshaft bearings out of line. Under load, this may cause actual wiping of main bearings.

There are two generally accepted methods of warming up heavy-duty diesel engines to normal, or near normal operating temperatures and thus eliminating excessive expansion strains, distortions, and misalignments.

1. Allow at least two hours for the warm-up period; start engine at low speed and increase speed every half hour. After two hours, engine should be running at about ¾-speed without load. Engine is then ready to take on load.

2. By-pass cooling water from other operating engines through engine to be started until water jacket temperature in down engine comes up to normal.

First procedure is better, and if combined with second, best. If management will not permit two-hour warm-ups on the ground that fuel is "wasted," and it cannot be sold on the long-term advantages of this procedure, the second alternative should be selected.

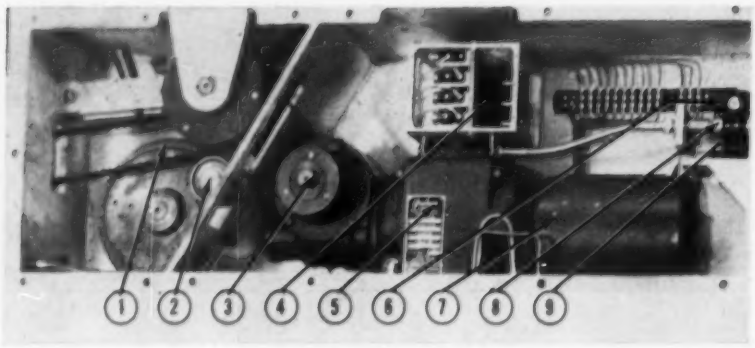
Wherever possible, circulation of cooling water through all engines in the plant is advisable if one or more are out of service. If this practice is maintained for the life of the engine, much trouble and maintenance expense with diesels can be eliminated.

In water conditioning... there's one way to be sure!

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

W. H. & L. D. BETZ, Philadelphia, Pa.

Photos Make Lubrication Much Easier



Lubrication Points

1. Metering Roller Gears
2. Belt Tighteners
3. Graham Worm Drive
4. Edge Control Cams
5. Graham Roller Drive
6. Speed Changer Motor
7. Graham Drive Motor
8. Speed Changer Output Shaft
9. Speed Changer Reducer

AS THE USE of automatic controls increases, both inside and outside the power plant, the task of keeping equipment adequately lubricated becomes more and more difficult. The need for good lubrication has increased, since the greater the dependence on a particular machine, the more expensive is a shutdown if the machine fails. However, lubrication is more difficult, because as machines become more complex they tend to have more and more points that must be kept lubricated, and many of these points are often hard to see and hard to get at.

The value of a lubrication program has to be judged by the extent to which it keeps machines properly lubricated. A detailed plan on paper for the lubrication of a particular machine is valueless when some of the lubricating points on the machine may be overlooked in practice because they are too difficult to locate.

Readers of POWER ENGINEERING may remember the excellent description of Eastman Kodak's lubrication program by C. L. Pope and C. R. O'Neill in our November 1954 issue. In their plant they have a large number of unusually complicated machines. For some of these, where lubricating points cannot be brought out to a convenient panel board, or where it is not convenient just to mark the points with white paint, they have resorted to the use of marked photographs to help the man who has to do the job.

The illustration above shows a typical photo with the lubrication points marked on it. In some instances it may be necessary to take more than one photograph of a particular machine if all the points cannot be seen in one view.

The method can be applied to many different types of machines, and it has been found to be very successful in practice. The photographic approach is much faster and costs less than making line drawings or blocking out unwanted details to give a simplified picture, and, furthermore, the photograph eliminates confusing terminology in identifying parts, for the observers can see for themselves exactly what parts are indicated.

Electric Current Flow De-Salts Earth

ELECTRICITY served by the Salt River Power District, Phoenix, Arizona, in a series of soil experiments on Salt River Valley farms is producing interesting results.

The experiments, under way here since December 28, 1955, are being handled by the Collopy Electro-Soil Co, Phoenix. The work consists of installing cathodes at one end of a farmer's field and anodes at the other, both joined to a rectifier by wires which can be left in the field or installed beneath the surface soil. There is no danger of electrocution to farmers or those who work the harvest. A dry plate selenium type rectifier is located at one end of the field. This converts 220 a-c to d-c with voltage between 62 and 65 giving between 7 and 16 amp.

Purpose of the experiments is to accelerate the reclamation of bogged and salted agricultural areas; to promote a better growth of crops; to produce an earlier maturity of crops; to control soil pests, and to provide a soil conditioner.

The experiments have proved that salt prevailing in many areas of the Valley have been driven into the earth and the earth has become more porous and able to absorb more irrigation water in a shorter time. Previously, to correct this type of condition long runs of irrigation water were required without very much success. After the electrical experiments the water runs were reduced considerably and effective results have been achieved.

First installation for the experiments was initiated in Deaver, Wyoming in September 1951. Those initial experiments, on a 5-acre plot and subsequent tests, proved that electrifying the soil could produce results if properly handled.

For the present series of experiments, 9 anode pipes of scrap steel, 2 in. diam and running east and west, were driven 4 ft into the ground, 30 ft apart. Across the field, cathodes, also of scrap steel, one in. diam, were also driven 12 ft into the earth. The wires connecting anode and cathode with rectifier were stretched 1200 ft across the field. This length can be adjusted according to the irrigation run. Shortest length handled in these tests was 600 ft.

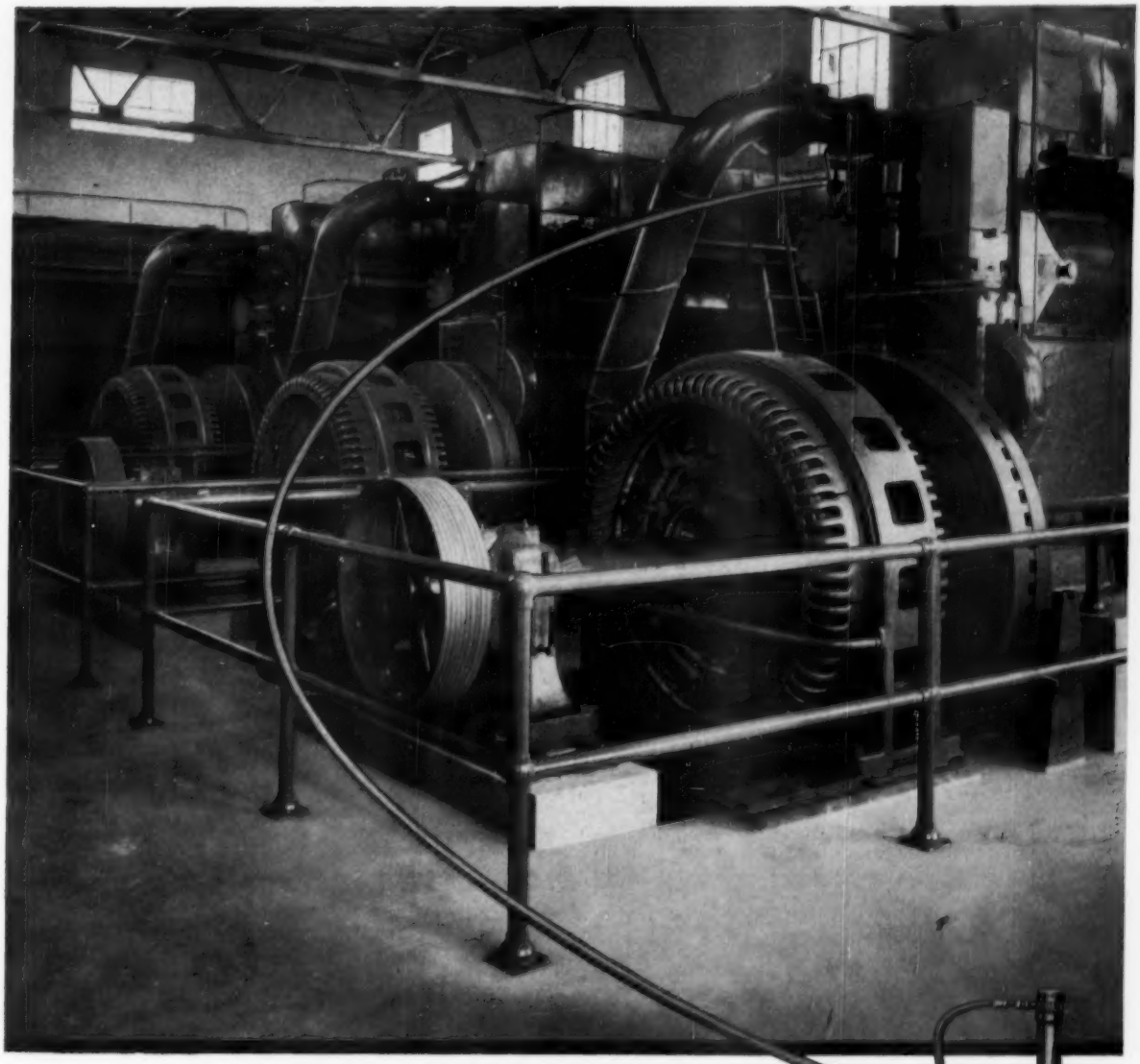
Tight, slick spots on a 10-acre plot which previously showed crop failure, are now producing abundantly.

Low cost of this method of soil electrification is a major factor in the success of the tests. During a 10-month period of constant testing on one ranch, 5462 kwh were used, costing about $156. Only 1900 kwhs were needed to increase the size and improve the crop of honeydew melons at another ranch. The cost of electricity per acre has averaged between $2.40 and $10 for the experiments.

According to the inventors of the process, the electrification of soil can be expanded to almost any size acreage providing additional rectifiers are added. So far, eight experiments have been conducted on various farms in the Valley.

The experiments are now being conducted in other States and the process varies depending on soil conditions.

These coöperative experiments are to be continued to further verify the satisfactory results already achieved.



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SINCLAIR RUBILENE OILS

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Extra Powerful X-Ray Machine Speeds Metals Research

AMONG THE MANY factors limiting development of steam turbines, nuclear reactors and heat exchangers, gas turbines, and other items of power engineering equipment, the behavior of metals at high temperatures is one of the most important, and improvements in metal properties set the pace for advances in a large range of equipment.

An extra powerful x-ray machine, designed by Dr. A. Taylor, a research scientist at Westinghouse Research Laboratories, is expected to make important contributions to the study of alloy behavior at high temperatures. It has already revealed valuable information about changes in the atomic arrangement of iron-aluminum alloys at high temperatures.

Up to now, certain changes were observed in these alloys at certain temperatures, but they were not clearly understood. With the use of this new high-intensity machine, it is possible to take x-ray photographs of these alloys during the precise moments when, due to temperature changes, the magnetic arrangements of the atoms in the metal is undergoing transformation.

This new machine is at least 15 times more powerful than most other comparable machines, and with it the x-ray beam can be concentrated on a focal spot less than half the normal size. This enables photographs to be taken in 1/15th of the usual time, thus speeding up work enormously.

This gives the machine a great advantage for work at high or low temperatures. For example, photographs have been taken at temperatures as low as − 300 F. This can probably be done with less powerful equipment, but because of the long exposure time that would be necessary, the cost of liquid helium would be prohibitive. With the new machine, the greatly reduced exposure time considerably reduces the cost of liquid helium.

In addition to conducting studies at low temperatures, the new machine has been used to take x-ray photos of metals as hot as 3000 F, making it possible to study the characteristics of the metal before it vaporizes or undergoes some chemical change at the high temperature.

New super-power crystallographic x-ray machine probes atomic structures

The machine is also equipped with an adapter which gives an x-ray beam only 400 millionths of an inch diam of This thin, intense beam approaches the dimensions of the lattice structure of a metal crystal, and permits the investigation of individual crystals with an exactness not possible with a beam of larger size.

Consolidated Edison Estimates Nuclear Power Cost

AT A RECENT Congressional hearing, Gordon R. Milne, Mechanical Engineer for the Consolidated Edison Co. of New York, reported to the joint Committee on the present status of the company's Indian Point nuclear plant.

In the course of his report, Mr. Milne gave some interesting figures on the estimated cost of power to be produced by this plant.

The reactor will be a pressurized water arrangement, using uranium as base fuel and thorium as the fertile material. Since this is the first application of thorium to a large power reactor, it was considered advisable to hold the nuclear fuel temperatures to moderate levels.

Since this would result in steam temperatures low in comparison with conventional steam generating practice, it was decided to effect further economy in the generation of electric power by providing a separate oil fired superheater to raise the temperature of the steam before its utilization in the turbine.

Heat produced by the reactor will result in electrical generation of 140,000 kw capacity. Adding the oil fired superheater will give an additional 96,000 kw of electrical capacity, or a total plant capacity of 236,000 kw.

Estimated cost of electric power to be generated by the Indian Point plant is shown in the table. This cost, including fixed charges at 13.5 per cent, fuel costs, cost of reprocessing nuclear fuel, and all operating and maintenance charges, should be about 9 mills per kwh.

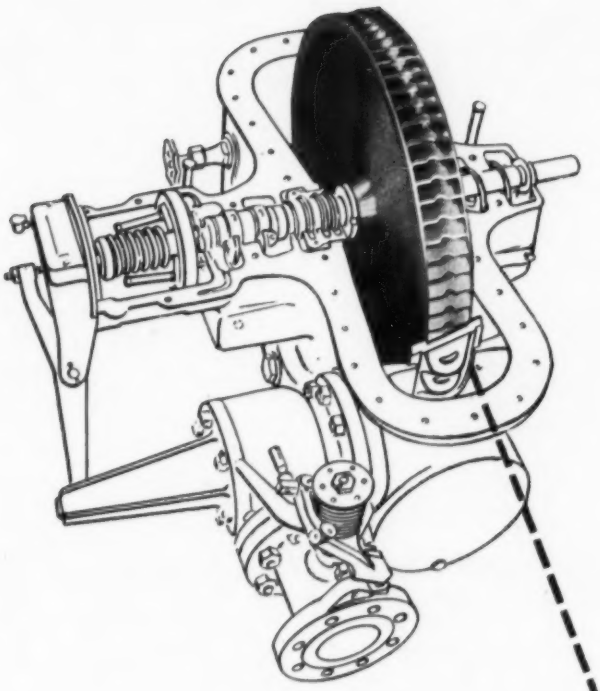
The cost of reprocessing nuclear fuels is at best an approximation, since commercial reprocessing plants have yet to be built and operated. The figure of 9 mills per kwh compares with 7½ mills which is cost of generation at Consolidated Edison's newest conventional steam plant.

ESTIMATED POWER PRODUCTION COSTS
INDIAN POINT NUCLEAR POWER PLANT

GROSS REACTOR CAPACITY—MW—HEAT	500
GROSS ELECTRIC CAPACITY—REACTOR	140
SUPERHEATER	96
TOTAL	236
NET ELECTRIC CAPACITY—REACTOR	130
SUPERHEATER	89
TOTAL	219
ANNUAL NET M M W H PRODUCTION (80% LF)	
REACTOR	910
SUPERHEATER	623
TOTAL	1533

ANNUAL COSTS	AMOUNT	CENTS PER KWH
FIXED CHARGES—55,000,000 @ 13.5	$ 7,430,000	0.485
FUEL—NUCLEAR OIL	4,650,000	0.303
OPERATION AND MAINTENANCE	1,500,000	0.100
TOTAL	13,580,000	0.888

Work Horse of Industry..since 1906



The Terry Steam Turbine Company was incorporated in 1906 to manufacture *a workable and efficient prime mover that would operate with minimum maintenance.* This prime mover was the solid-wheel turbine, which had been invented by Edward Clinton Terry a few years before.

Although maintenance practice has improved vastly since then, the demand for the turbine has multiplied many times. *Rising maintenance costs have actually increased the need for trouble-free operation.*

Today, there are more Terry solid-wheel turbines in operation, and there are more built each year, than ever before. The explanation is simple.

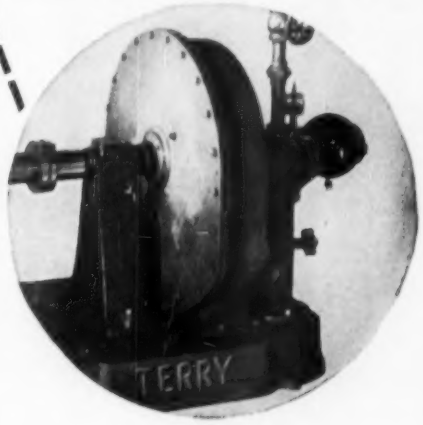
Here is a turbine with a virtually indestructible wheel. Made of a single forging of special composition steel, there are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which may occur does not materially affect horsepower or efficiency.

Blades will not foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

These are a few of the reasons why the Terry solid wheel turbine has been the *work horse of industry — since 1906.* For the full story, send for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



1906 was the year this turbine was built in Terry's plant. It is believed to be one of the first small direct-connected turbines built for commercial use in the United States.

TT-1203

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Make-It-Yourself Magnetic Chuck

BY SHIRLEY D. PRICE *

THIS MAGNETIC chuck was made to be used in our machine shop, where we had no d-c supply.

Using a ½ hp, 110 v a-c, 1725 rpm motor, obtained from an old washing machine, we connected it to a 3-brush car generator, running the generator at a speed of 1475 rpm. This generates slightly more than 6v. The motor and generator were mounted on a small platform with casters so it could be moved about the shop when needed. In the cord that was hooked to the 110-v a-c supply we put another cord with an off-on switch so the unit could be controlled by the operator wherever it was located. We also attached a four-blade 8-in. fan to the generator pulley to help cool the generator.

Fig. 1. This magnetic chuck holds work for grinding sides of three over-size lathe tool holders

The box for the magnets and wiring was made from flat iron welded as shown in Fig. 2. All four corners were electric welded and rounded off to give a neat appearance; then the base was welded to the sides to make the box for the electric coils. Holes were drilled in the bottom of the box to receive ¼ in. by 1 in. cap screws, and the holes were countersunk to bring the screw heads flush with the bottom of the box. Slots were cut at each end of the box to receive the ½ in. bolts we used to clamp the magnet to any surface on which it was going to be used.

Close to the bottom and on the side of the box we drilled three ½ in. holes and filled them with felt to let air circulate around the coils. The felt was held in place with a spring clip.

The small pieces of felt should be torn apart or shredded like fluffy cotton and then pressed lightly into the ½" holes. The felt will not fall inside the magnet because it will lay against the wire on the inside. The spring clips are just to keep the felt in position. These holes are not an absolute necessity because the wiring was so designed that there would not be any excessive amount of heat generated by the coils, but I would suggest using them for your own protection.

* Rocky Ford, Colorado

fold along this line—outside edges toward you

Magnet cores were made from structural T iron, as shown in Fig. 3. Two holes were drilled and tapped in the bottom of each core to receive an N.C. 3/16 in. bolt with countersunk head. All 6 cores were spaced equally on a 1½ in. by 2 1½ in. by 8 1¼ in. piece of flat iron. This base of the cores was in turn placed in the bottom of the box and anchored tight with the six ¼ in. cap screws.

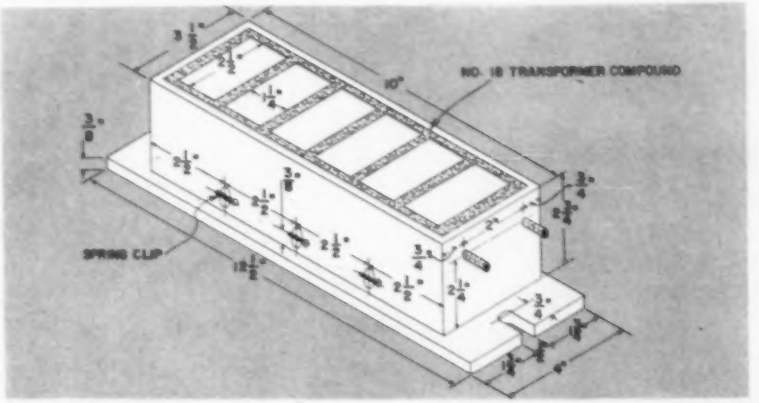

Fig. 2. Isometric view of magnetic chuck assembly, showing dimensions for fabrication and assembly of parts. Three spring clips shown in this view retain felt washers that permit interior to "breathe"

Before each core was anchored, the magnet wire was wrapped on it. First a single layer of fishpaper, .006 in. thick, was wrapped round each core, and then a single layer of .007 in.-thick Empire tape. At the same time top and bottom pieces of fishpaper and Empire tape were cut and placed to prevent the magnet wire touching the metal of the cores at any point.

For winding each magnet we used 190 ft of #17 enamel coated magnet wire, giving 209 turns per pole. We used two strands of #17 wire in parallel instead of one larger size wire because it was smaller and easier to wind into a coil, although we still maintained the same current carrying capacity.

Between each layer of wire we placed a layer of masking tape to help keep the winding flat. The winding was done in a regular machine lathe. Direction of winding was the same for each coil, but to get the opposite flow of current in alternate windings we connected the finish end of coil #1 with the finish end of coil #2, and then connected the start of coil #2 with the start of coil #3.

Following this procedure will give you the correct direction of current flow as shown in Fig. 4. The two leads were brought out through two holes in the end of the box by way of two bolts that were insulated from the box.

Method of making each bolt assembly was as follows: A hole of ½-in. diam was drilled in the end of the metal box and a fiber bushing was inserted in the bushing. Then one fiber washer was put on each side of the fiber bushing and tightened with two brass nuts. The magnet lead wire was attached to the brass stud and tightened securely. If this is done correctly there is no possible way for the metal stud, nuts, or wires to become grounded to the metal chuck. If the chuck is to be used where water or liquid is present, you will have to seal off the six air vents on the sides and use watertight connections on the two lead-in wires. When we are doing dry grinding we use the felt in the holes, but if we want to use the grinder in a situ-

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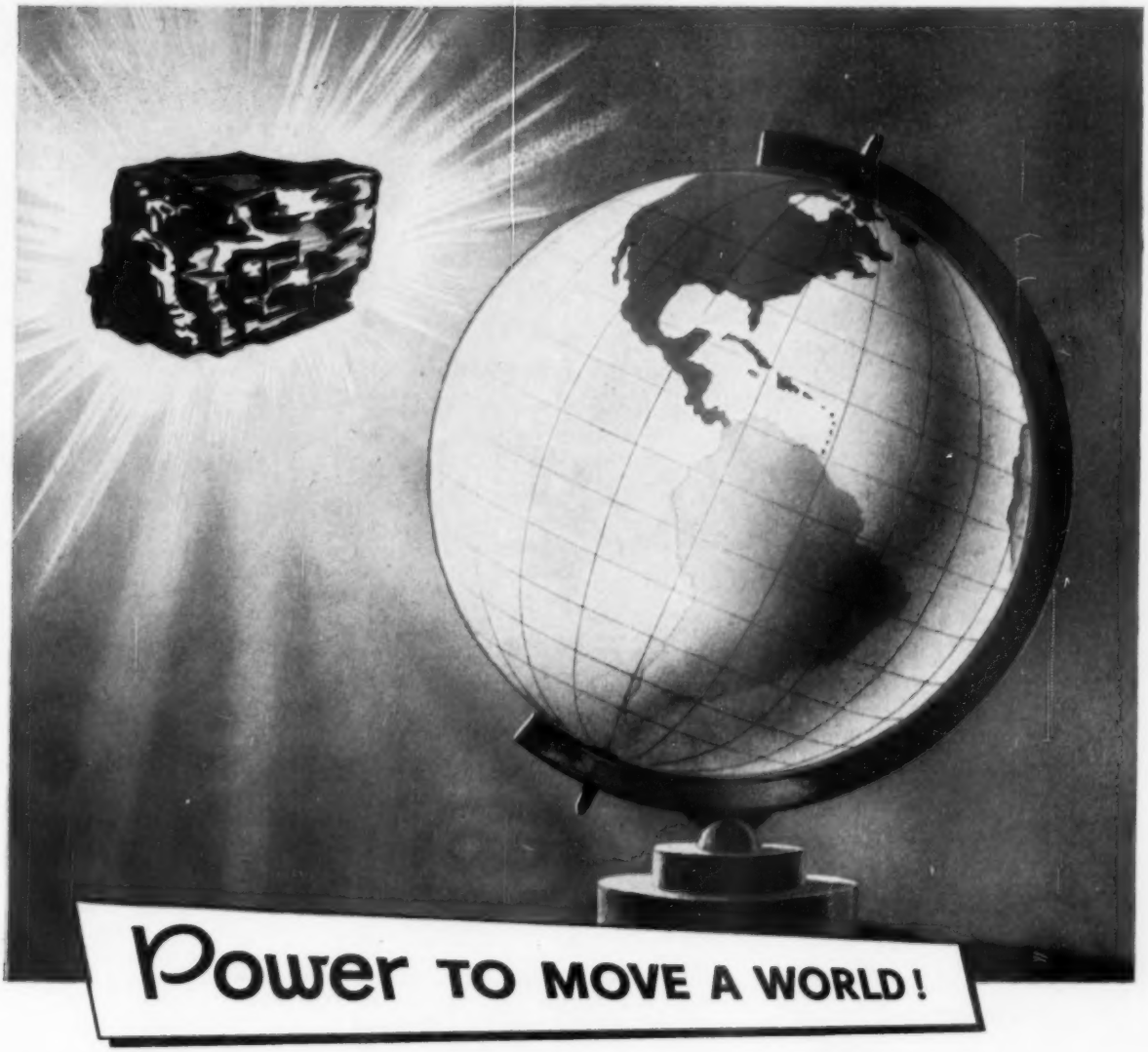

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ation where liquid coolant flows down over the magnet, we remove the felt and close the holes with putty before continuing with the grinding operation.

The next step is to seal with compound the spaces between the pole pieces so no metal particles can reach the windings when the chuck is in operation. To do this the magnet assembly was first correctly positioned in the box. Then a piece of thin cardboard was cut out so that it would fit over all the pole pieces and also fit inside the box, as shown in Fig. 4. The cardboard was pushed down until it was level with the tops of the windings (about ¼ in. from the top of the pole pieces). Then the cracks between the cardboard and the pole pieces, and between the cardboard and the inside of the box, were sealed with asbestos paste. Then the compound (#18 Transformer Compound) was heated to a running temperature, poured around the pole pieces, and left to harden.

Next step was to put the whole chuck upside down on a surface grinder and grind a true face on the bottom. Then it was turned over and the top was ground to be perfectly parallel to the bottom. When grinding the tops of the pole pieces the compound can be scraped to about .003 in. below the surface of the top plates of the magnet before this last grinding operation takes place.

The chuck is now ready for use. It will have a lifting power of approximately 80 lb. For winding the coils, 8 lb of #17 enameled magnet wire is more than enough. The electric motor can be taken off practically any washing machine or other appliance. The generator can be purchased at an automobile junk yard, the flat iron from a machine shop, and the transformer compound and magnet wire from any electrical shop.

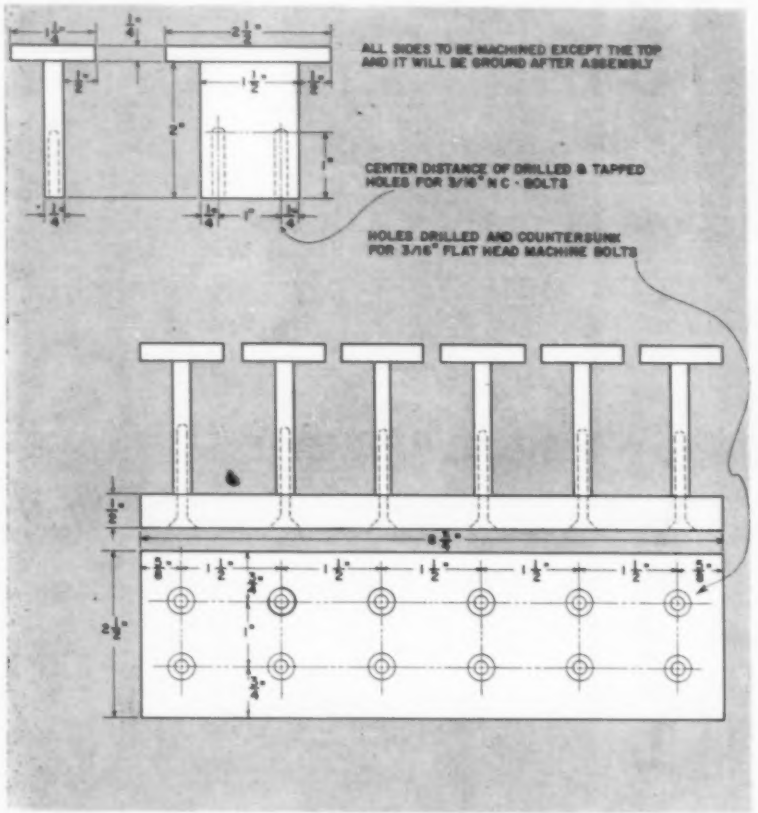
ALL SIDES TO BE MACHINED EXCEPT THE TOP AND IT WILL BE GROUND AFTER ASSEMBLY
CENTER DISTANCE OF DRILLED & TAPPED HOLES FOR 3/16" N C - BOLTS
HOLES DRILLED AND COUNTERSUNK FOR 3/16" FLAT HEAD MACHINE BOLTS

Fig. 3. Magnet cores for magnetic chuck and method of fastening to core base; lay out holes carefully

fold along this line—outside edges toward you

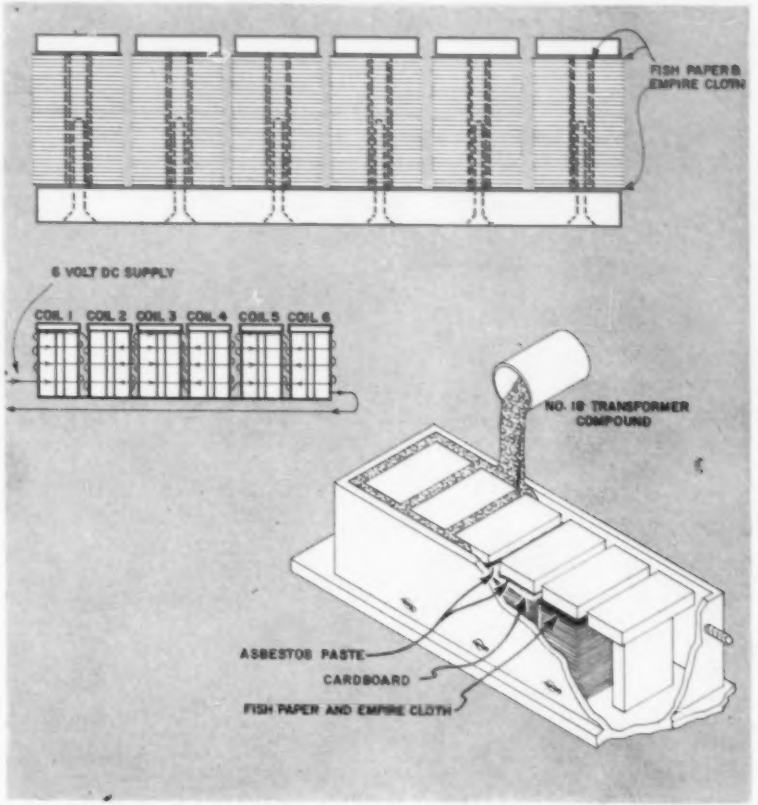
FISH PAPER & EMPIRE CLOTH
6 VOLT DC SUPPLY
COIL 1 COIL 2 COIL 3 COIL 4 COIL 5 COIL 6
NO. 18 TRANSFORMER COMPOUND
ASBESTOS PASTE
CARDBOARD
FISH PAPER AND EMPIRE CLOTH

Fig. 4. Top, method of winding magnet cores; center, direction of current flow; bottom, sealing method

cut along this line

Hall Industrial Water Report

VOLUME 5 FEBRUARY 1957 NUMBER 1

Unscheduled Boiler Outages Are the Hobgoblins of Steam Plants

With demand chasing capacity like the famed headless horseman, unexpected loss of a boiler can really be a nightmare. Routing these nightmares by helping operators to keep steam plants trouble-free is the function of chemical engineers skilled in water technology. Hall Laboratories assists thousands of plants to keep their boilers on the line.

Package Boilers Operate Continuously

Three shifts a day, seven days a week, for over five years, with 100 percent make-up of zeolite softened water, the two-drum package-type boiler at a chemical manufacturing plant in Pittsburgh has performed without one unscheduled outage due to water.

The boiler is a 25,000 pounds per hour unit with continuous one and one-half inch floor, wall and roof tubes. Hall engineer L. C. Bishop reports that these tubes have never had to be acid cleaned nor turbined. Plant management was immensely pleased when a recent inspection showed the tubes and drums to be virtually like new.

This record is a tribute to the careful water conditioning work done by the operating men under the guidance of Hall Laboratories.

Spring Exam No Terror At This College

For some years a college in Massachusetts had treated boiler water with trisodium phosphate in a hit or miss manner. Each spring the boiler tubes were so dirty with sludge and scale that the engineer had to clean them by running a knocker turbine through the tubes and following up with a cutter turbine.

A couple of years ago the college retained Hall Laboratories to set up more satisfactory water conditions. The last time the boilers were inspected it was no longer necessary to use the knocker turbine. As a matter of fact, the cutter turbine was used only as a precautionary measure and the time spent on the job was only half that previously required.

J. A. Gregory, the Hall engineer who services the plant, points out that this job is a good example of how a Hall engineer, with the co-operation of the operating men, can clean up a bad boiler deposit problem.

Value of Water Treatment No Day Dream

G. W. Rudolf and T. A. McConomy, engineers in Hall's Washington, D. C. office, recently inspected three boilers at an Atlantic Coast shipbuilding company.

One of the boilers had been retubed and had operated with water conditions recommended by Hall since being returned to service. The second had operated about eight months without boiler water treatment and then four months with Hall recommended water conditions. A third boiler had operated for approximately eight months without treatment.

The first boiler was found to be free from scale and corrosion with just a very small amount of loose sludge in the mud drum. There was a large accumulation of loose scale in the mud drum of the second boiler, indicating that proper water conditions were resulting in removal of the scale which had been deposited when no water conditioning was practiced. The third boiler was very badly scaled and turbining was necessary to put it in shape for further operation.

With this clear-cut evidence, the plant operating men were completely convinced of the value of Hall supervision of water conditioning.

Expert Diagnosis Ends Plant's Troubles

Unhappy about the corrosion and deposits occurring in their steam plant, a Canadian rubber manufacturing company sought out Hall Laboratories to help them with their problems.

J. S. Sullivan, one of the service engineers in Hall's Toronto office, conducted a survey of the boiler and condensate systems as a first step in bringing the plant to trouble-free operation. Boiler water conditioning for scale prevention was necessary, but by measuring corrosion rates in the condensate systems Sullivan was able to show that condensate treatment was unnecessary.

After setting up a regular chemical feeding schedule and prescribing control tests and procedures, Sullivan nursed the plant along during frequent service visits, suggesting desirable changes as treatment progressed.

A recent boiler inspection report stated that the boiler was in very good condition internally. This is the second unit to receive such a favorable report since the plant started to use Hall system.

When the editors of the Encyclopedia of Chemical Technology wanted a concise discussion of "Water, Industrial" for the final volume of their series published in 1955, they asked Dr. Everett P. Partridge, Director of Hall Laboratories, to write it. Reprints have been distributed recently to Hall clients. If you would like a copy of this 21-page chapter, it is yours upon request.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Division of Hagan Chemicals & Controls, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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New Method of Fitting Bearings

FRETTING CORROSION, one of the most troublesome problems encountered with anti-friction bearings, can now be avoided by means of an easily-applied plating process. Using new techniques and materials, the so-called Dalic process makes it possible to achieve a tight, uniform fit between the bearing rings and housing (or shaft), thus eliminating "three-point-fit." Even under severe vibration, the bearing will remain in place, will not seize the shaft, nor cause galling or other damage.

In essence, this process deposits a thin layer of soft metal on the outer surface of the bearing rings; the soft metal conforms to slight irregularities during press-fitting or compresses in a shrink-fit, and completely fills the space between the bearing and the stationary machine member. Four metals have been found suitable for this purpose: tin, cadmium, copper, and silver, but for all-around practical considerations, tin is most often used.

The new process offers a simple means of area plating; only that section of housing which is to receive the bearing need be plated, eliminating the necessity of immersing the entire unit in electrolyte. The equipment consists of a special rectifier, with a finely graduated voltage control to permit deposits accurate to within 0.00005 in., two leads, and plating solution. The cathode is clamped to the work, the anode to the stylus with which the plating solution is applied. Several types of styluses are available: plug-type, cap-type, either air-cooled or water cooled.

Plating operation is extremely simple. If small enough, the housing (or shaft) is chucked in a low-speed lathe, and rotated. The cathode lead is connected to the lathe, the stylus in the anode is wrapped in ordinary cotton, and the right voltage is selected on the rectifier. The cotton swab is dipped in plating solution, then held against the rotating bearing housing. For best results, the housing should first be cleaned electrically; the same apparatus with a special cleaning solution can be used.

If the housing is large, the same results can be obtained by swabbing the wet stylus around the periphery of the surface to be plated. Or, alternatively, the bearing itself may be chucked, and the ring surfaces plated. In the latter case, precautions must be taken to prevent

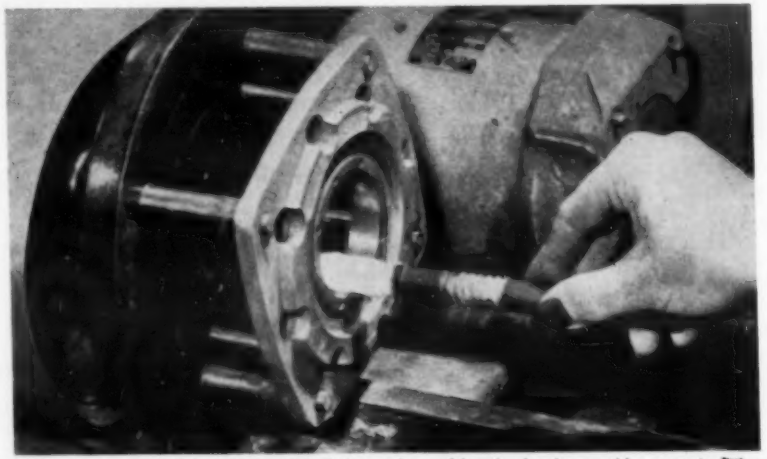

Fig. 1. Dalic process of depositing metal plating on bore of bearing housing provides accurate fitting

fold along this line—outside edges toward you

Fig. 2. If necessary, process can be applied to bearing itself, but keep electrolyte from races

electrolyte from entering the races.

The process permits exact bearing fits without the need to machine or grind bearings to size, and allows much larger tolerances. It is particularly useful wherever vibration is encountered, such as in electric motors and generators, and other high-speed machinery.

Deposit thickness will vary with the size and type of bearing, and the service it will encounter. In general, however, tin plating of about 0.0002 to 0.0005 in. on most surfaces will be enough to give a tight, vibration-resistant fit. Where more build-up is needed, this, too, can be accomplished, although it may be necessary to alternate metals (table).

Under normal circumstances, the voltage control is set at about 12 v, which yields a current density of 10 amp per sq in., much higher than those common in commercial plating equipment. The resulting deposit, obtained in about 2 to 3 minutes, is extremely dense and free of porosity or pin-holes.

For more information on this process, write the Editor, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill., or jot down "Fitting Bearings" on Reader Service Card.

Thickness, technique for precision bearing fits

(A) Difference in mating diameters, inches	(B) Total deposit thickness, inches	(C) Technique
0.0015 or less	(See note below)	Deposit tin only to thickness B
0.0015 to 0.0055	"	Deposit (B — 0.0005) in. of hard nickel. Finish off with 0.0005 in. tin
more than 0.0055	"	Alternate 0.001 in. hard nickel with 0.0001 in. copper to a total thickness of (B — 0.0005) in. Finish off with 0.0005 in. tin

Note: Required total deposit thickness is always one-half that of the difference between two mating diameters (B = ½ A).

Lathe Tray for Small Tools

A COMMON practice in lathe work is to lay a board across the bed ways and to place small tools and measuring instruments on this. If the board is placed to the right of the tailstock, it is often too far away to be conveniently reached by the operator. If the board is placed at the left of the tailstock within easy reach, it has to be shifted every time the tailstock is moved.

Some commercially obtainable lathes have a tool tray cast integrally with the top of the tailstock casting. Other lathes can utilize this very handy idea by the method shown in the illustration. Make a wooden tray to fit on top of the existing tailstock casting. This is a method much superior to the other simple expedient of laying small tools on the lathe bed surface.

cut along this line

Twin Benefits from Mead-Morrison COAL UNLOADER

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because of Mead-Morrison's progressive reeving system

This system, originated by Mead-Morrison, utilizes a single continuous rope for both the hoisting and closing motions of the grab bucket. The rope is fed into the system from a storage reel in small increments to replace worn portions of the rope. By thus distributing the wear the rope is used more efficiently and a longer rope life is realized than is possible with any two-rope system.

Greater Safety

because of Mead-Morrison's "dead man" control

All motions of the bucket are controlled by two short, latched levers. The operator is not forced to shift his hands from these levers at any time in the operating cycle. If the operator removes his hand from any lever for any reason, that motion is automatically stopped, thereby preventing uncontrolled motion.

This Mead-Morrison Tower installed at the R. E. Burger Station of the Ohio Edison Company at Dilles Bottom, Ohio, is a 10 ton stationary coal barge unloader with a free digging capacity of 1200 tons per hour. A Mead-Morrison barge haulage system works in conjunction with the tower.

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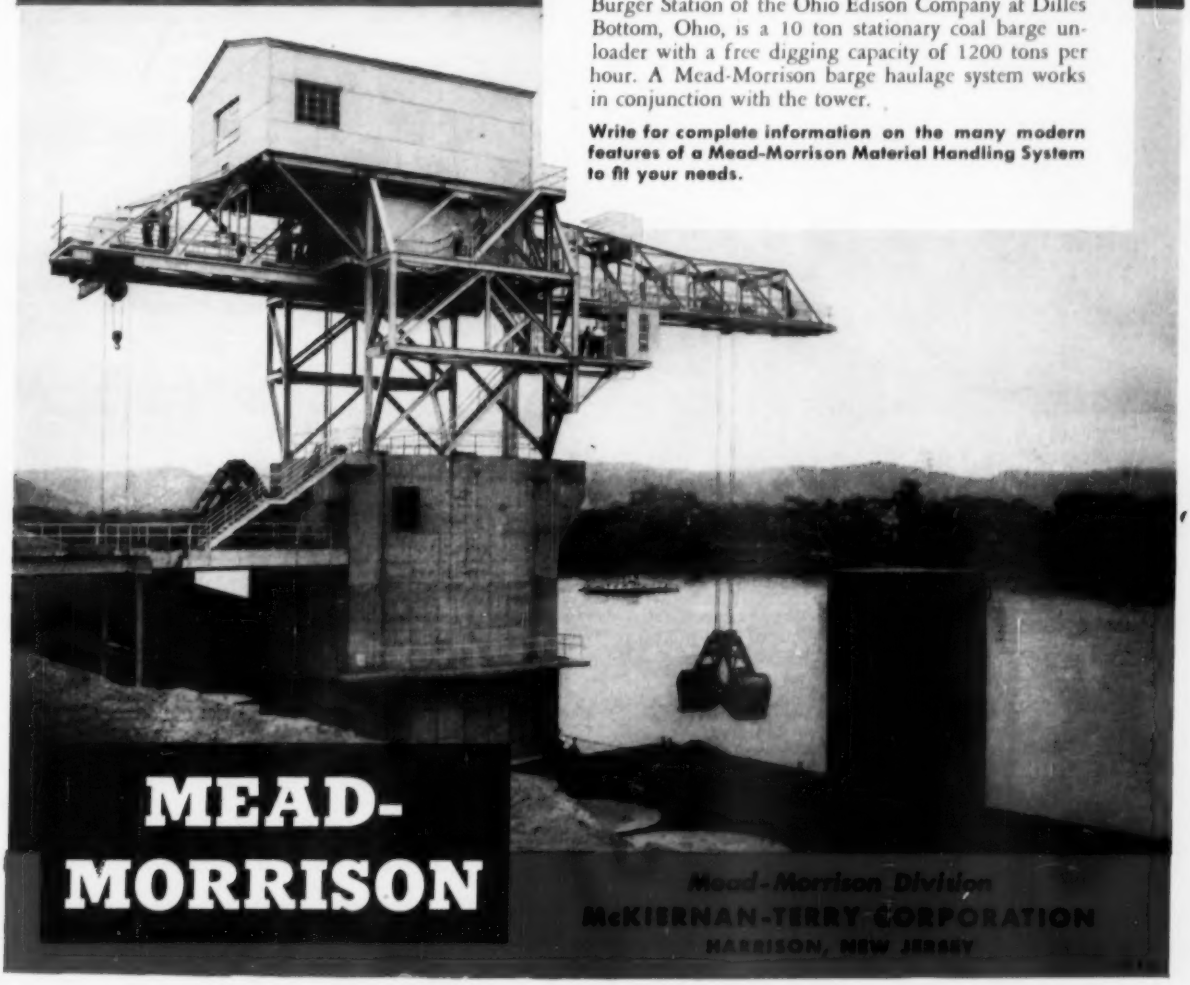

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Fusion Power

continued from page 78

way the physicists were able to produce in miniature what astronomers called *barred* nebulae as well as the many armed spiral galaxies we have seen in the far reaches of outer space through our great telescopes. Thus, further study of these tiny plasmoids, existing for less than a millionth of a second, may furnish us with clues for a better understanding of the origin and mechanism of the universe. In the meantime these experiments also should throw further light on the mysteries of thermonuclear processes.

Since thermonuclear reaction depends upon the production of high temperatures there has been much interest in the production of such high temperatures by the shock wave method. Dr. A. C. Kolb has been working in this field at the Naval Research Laboratory and has developed methods for producing high velocity one-dimensional shock waves in various gases. It was found that shock waves in deuterium with velocities in the 5 to 25 cm per microsecond range at particle densities varying between 10^{16} and 3×10^{17} cm^{-3} can easily be reached by coupling external magnetic fields to a high voltage, low inductance discharge.

Despite the unnecessary classification of the work we in the U. S. are doing in thermonuclear research, it is obvious from the little information that has been disclosed that a great amount of effort is being directed toward the solution of the problem. There are, however, a great multitude of formidable obstacles which must be overcome before a controlled fusion reaction can ever become a reality. Though we are still in the early stages, many of the scientists now engaged in the work are fully convinced that a power-producing thermonuclear device will eventually be built.

The success of a practical thermonuclear reaction may depend upon some new breakthrough in scientific research. As these lines are being written comes a report from the University of California of a new type of nuclear reaction that yields energy and is akin to thermonuclear reactions. It is a sort of catalytic reaction in which a mu meson (a transient particle generated by high energy particle accelerators, possessing a negative charge but having a mass 210 times greater than an electron) causes a proton and a deuteron nucleus to fuse together to form a helium-3 nucleus. After the reaction the mu meson is ejected and may act to establish another union of a proton and deuteron before it decays. Bubble chamber photographs at Berkeley showed cases where a single mu meson catalyzed two nuclear reactions before decaying. While it is too early to speculate upon the full sig-

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Case story of exceptional results obtained with Standard Oil diesel lubricants

Because of plant operating conditions and generator capacity installed, Aitkin, Minnesota, Municipal Light and Power Plant had to operate a 1,235 H.P. Worthington engine over 38,000 hours before it could be taken out of service for complete overhaul. During that time, 19.2 million K.W.H. were generated. STANDARD HD Oil, predecessor to STANODIESEL Oil M was the lubricant.

When the engine was overhauled, all pistons were in good condition. All rings were free to move in ring grooves. There were no scars on cylinder liners. Piston walls were bright, wear was even. Based on this performance from STANDARD HD, plant management converted to the improved new oil—STANODIESEL Oil M—at the time of overhaul. STANODIESEL Oil M has been giving top performance ever since.

STANODIESEL Oil M is made from highest quality base stock. Additives help the oil resist viscosity change and keep parts clean. Other additives control foam, keep highly stressed parts lubricated.

Get more information about STANODIESEL Oil M from your Standard Oil industrial lubrication specialist. There is one near you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

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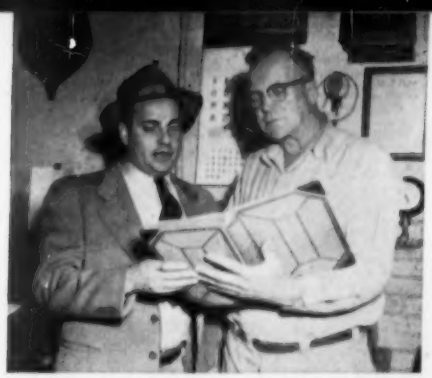

John Acklestad, Aitkin plant superintendent, and Carl Klenner (left) Standard Oil industrial lubrication specialist check engine service record. Carl has been rendering technical service on lubrication problems at Standard Oil for eight years. He has a degree from the Michigan College of Mining and Technology and has completed the Standard Oil Sales Engineering School.

"As is" photo of piston removed from engine after 38,000 hours of service. Rings were free.

Quick facts about
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- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate areas and parts.
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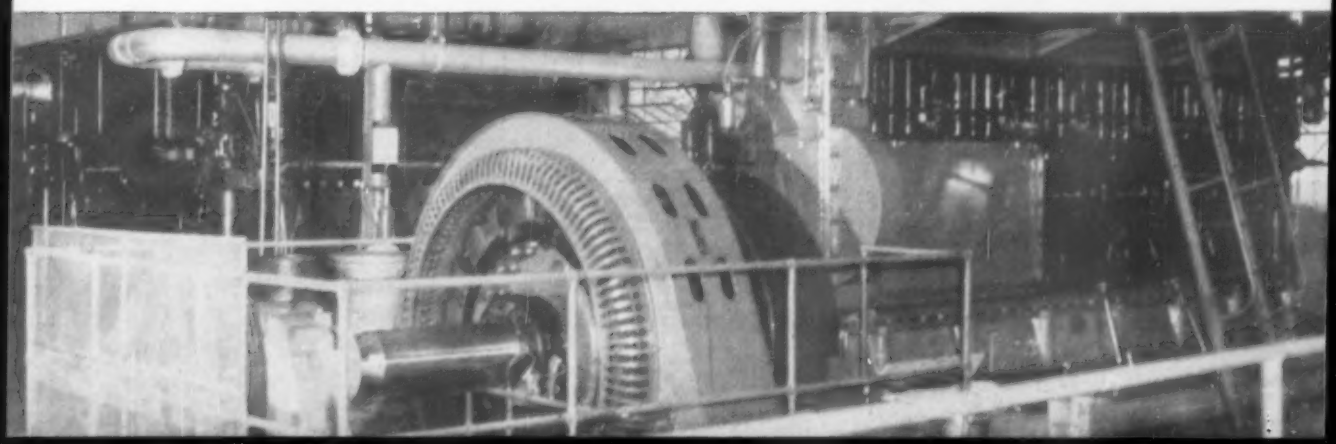

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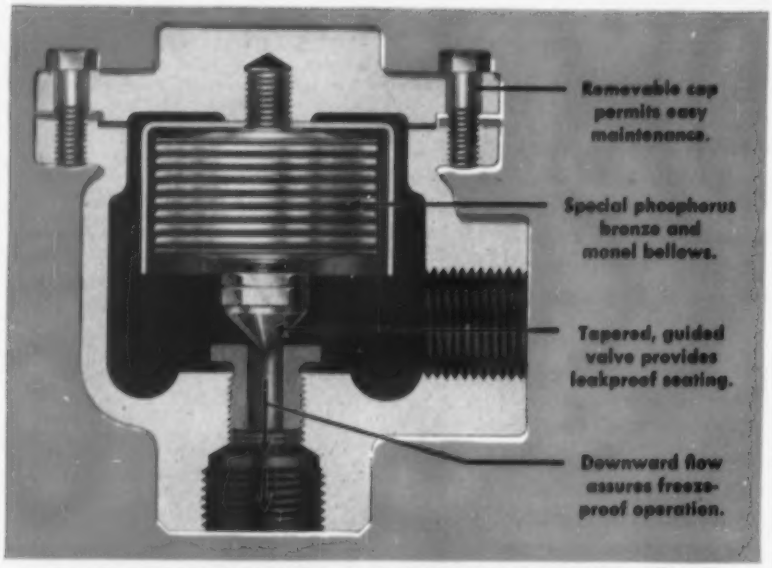
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Fusion Power

continued from page 112

nificance of this new discovery, it is possible that by some such method as this we may be able to promote energy-producing fusion nuclear reactions without the need of the excessively high temperatures which characterize thermonuclear fusion reactions.

One curious aspect of thermonuclear power is that both in nature and in the laboratory, thermonuclear reactions are the most obvious ways to release energy from the atom. The sun as well as all the stars maintain their energy by this process. The fission of uranium and plutonium actually is an odd freak, uncommon in nature and requiring very special conditions for its production. And while we will build fission reactors for a long time to come the fact still remains that the uranium and thorium resources of the world are limited and that sooner or later we will have to turn to thermonuclear power.

As Dr. Richard Post said at the ANS meeting, if you don't believe fusion power will be realized, you don't have faith in the scientific method. However, if you think it is easy, you are foolish.

Energy From The Sun

continued from page 97

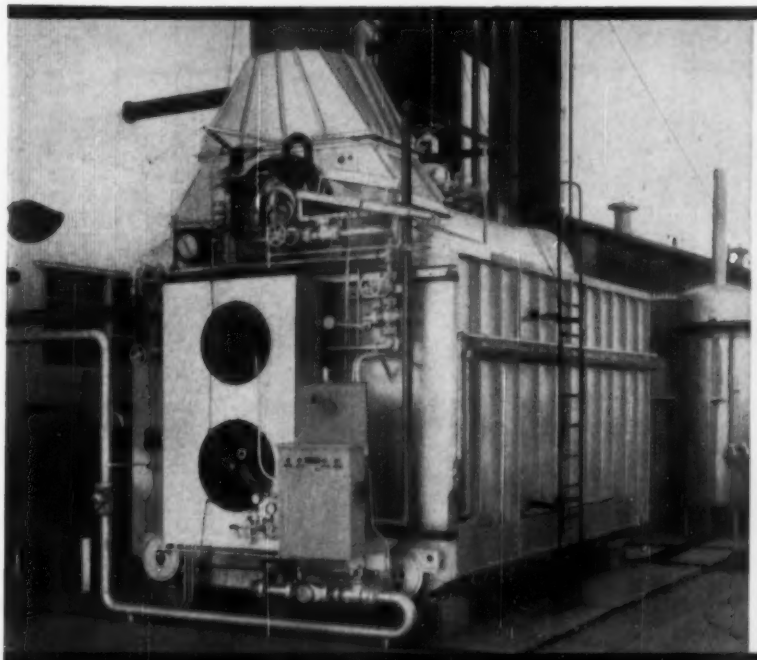
Direct current can be generated by sunlight falling upon several kinds of photocells. The oldest, least efficient, and cheapest of these is the selenium cell which constitutes the familiar electric eye. Its efficiency calculated by dividing the power output by the energy input is about 1 per cent, which is enough to justify its use for control devices, flame-eyes, etc., but not for power generation.

Several years ago, a team of Bell Laboratories scientists found a new photo-electric element in the so-called silicon p-n cell. This adventure in solid-state physics is a version of the transistor which is rapidly replacing conventional three-element vacuum tubes. A thin section of crystalline silicon, very slightly contaminated with arsenic and boron, has the happy property of converting 10 to 15 per cent of incident solar energy into an electric current. The output of each cell ranges up to 0.6 v, and 12 cells, in a series-parallel arrangement, can easily run a small radio and charge a battery to provide power in sunless periods.

Where economics is the determining factor, solar energy in the form of heat at 100 to 160 F is already competitive in the southwestern parts of the United States. The balance must lie between lower fixed charges and high energy costs for

UNION PACKAGED BOILERS

give Tri-Valley the steam it needs to pack 3,200,000 cases of canned food



30,000 lbs. of steam per hour — that's the capacity of this Union Type MH Steam Generator serving Tri-Valley's San Jose cannery. It's part of a complete boiler plant designed and constructed by Union's West Coast affiliate, Union Iron Works of California, Inc.

PEAR-LADEN CONVEYORS keep production on the move inside Tri-Valley's San Jose plant.

BIRD'S EYE VIEW of Tri-Valley's Modesto plant which utilizes a 30,000 lb./hr. Union Packaged Boiler for process steam.

Producing 24 varieties of canned foods, Tri-Valley Packing Association is one of California's largest independent canners. In 1955, it packed 58,000 tons of raw fruits and vegetables... *3,200,000 cases!*

Providing steam for the canning process as well as for operating cannery process equipment in each of Tri-Valley's two recently-modernized plants is a 30,000 lb./hr. Union Type MH Packaged Steam Generator.

In 1953, Tri-Valley's first MH Unit went to work in the Modesto plant. When the Association's San Jose plant needed a new boiler in 1955, another Union MH Packaged Boiler was picked for the job. Says Tri-Valley, "Our selection was based upon our evaluation of the design... and the performance of the Union MH Packaged Boiler installed in our Modesto plant."

The efficiency of the new Union Generator at the San Jose plant has been checked at 77.88% on gas firing at 33,000 lbs./hr., which is 10% over rated maximum continuous output.

From coast to coast, Union Packaged Steam Generators are stacking up impressive job records in chemical processing plants, pulp and paper mills, breweries, refineries, institutions, schools and hospitals, to name but a few.

Completely shop-assembled at Union Iron Works for delivery via rail or truck, Type MH Units can be equipped to handle multitudes of needs formerly requiring costly field erection and special engineering. Standard units are designed in 13 sizes from 10,000 to 50,000 lbs. of steam per hour.

GET THE FULL STORY including cut-away illustrations, tube lay-outs and dimension tables by writing for Bulletin MH-353.

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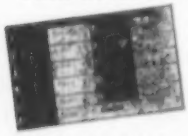

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Energy From The Sun

continued from page 114

conventional equipment, and higher fixed charges for solar equipment where there is no cost for the Btu's.

Solar heating, with water, ceramic, or chemical storage, is already a reality in Arizona, New Mexico, Colorado, and Massachusetts. The water-to-air heat pump, which does double duty as an auxiliary heat source in winter and a cooling unit in summer, is certain to become much more widely used as oil and natural gas become scarcer and hence more expensive.

Air conditioning by solar energy is in its infancy, but it offers an excellent application. The cooling load in summer is a function of the amount of solar energy, which means that radiation-powered cooling equipment would have the greatest capability when the need is greatest. Absorption refrigeration looks like the most promising process for this application.

When physicists discover new ways to generate electricity directly from radiation, without going through the thermal cycle, both nuclear and solar power will move forward rapidly. Until that time, solar plants will probably continue to be relatively small and applicable only to special purposes such as irrigation and power production in isolated locations. The present silicon cells are now competitive with battery power and in time their cost will be reduced to the point where they will be more widely used.

Other devices for utilizing solar energy are shown in Figs. 3 and 7. Figure 3 shows the Somor Solar Pump, while Fig. 7 shows the Hoffman Electronics Corporation's "Big Bertha", a 400 cell solar energy converter, using silicon solar cells. In the lower left edge is the tracking device which allows the unit to follow the sun across the sky for maximum efficiency. In bright sunlight, the unit can convert the sun's energy into about 10 watts of electrical energy.

Solar radiation is the one inexhaustible energy asset which our world possesses. Up to the present time, mankind has been able to draw upon the capital energy in the earth's fuel bank, but the time will come when this energy will be scarce and hence expensive. Research is needed now to learn how to use solar energy cheaply and effectively to heat and cool our homes, produce fresh water from salt, and ultimately to generate large blocks of electrical power.

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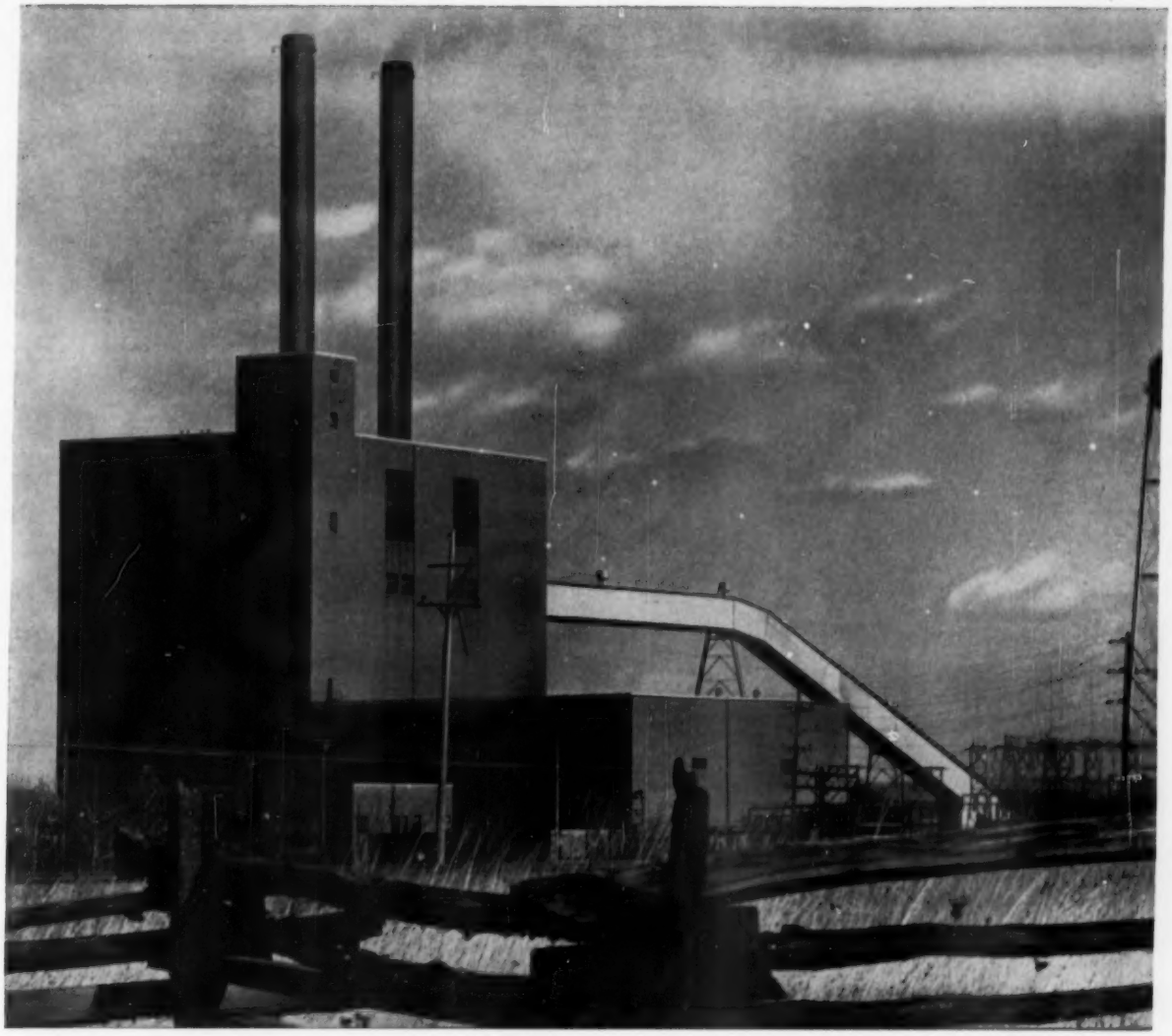

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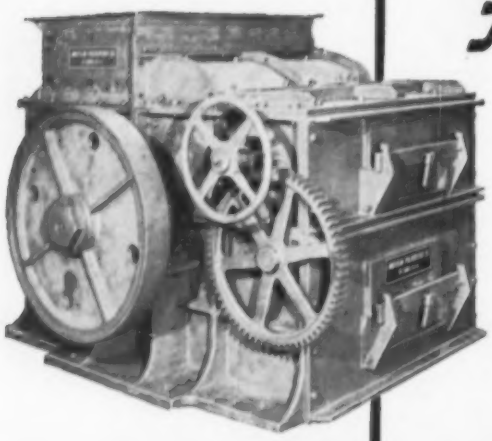

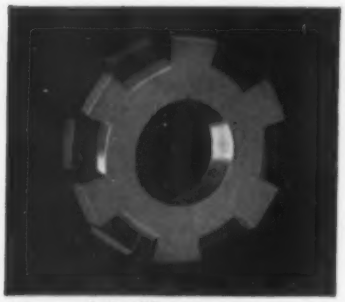

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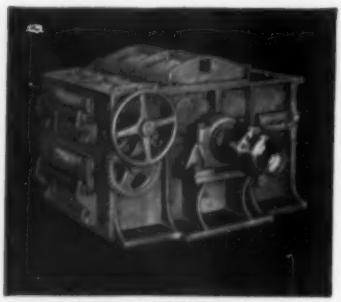

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Energy From The Sun

continued from page 116

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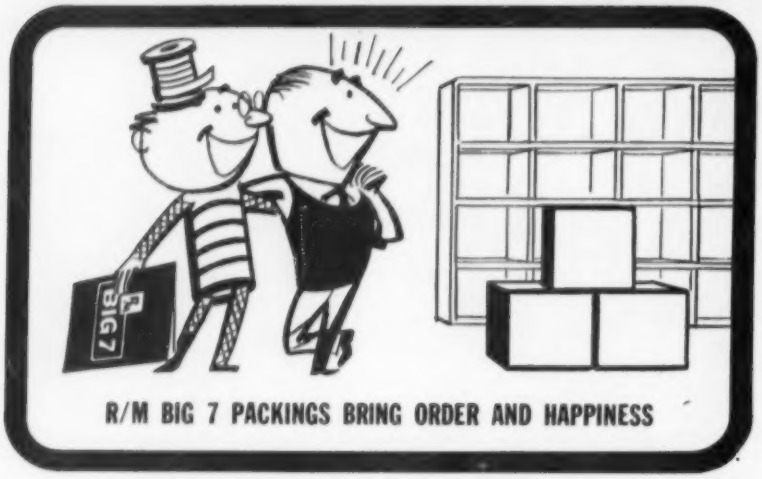

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Engineering Books

continued from page 118

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Vol. 16. Record of the Conference. Approx 350 pages. Price $5.00

★ ★ ★

Criteria for Professional Employment of Engineers, prepared by Engineer-in-Industry Committee, NSPE. 23 pages, paper cover, size 5¼ by 8½ in. Published by National Society of Professional Engineers, 2029 K Street, N.W., Washington 6, D. C. Prices: single copies 25 cents each; 10 to 49 copies, 20 cents each; 50 to 99 copies, 15 cents each; 100 or more copies, 10 cents each.

In order that the engineering profession may make its maximum contribution to society, engineers and their employers must coöperate to establish a climate in which the engineers can assume their professional responsibilities and obligations. This booklet can help establish such a climate.

Printed in check-list format, the criteria cover specific categories of engineering development. Topics included are recruitment, indoctrination, professional development of the individual, salaries, engineering titles, personnel practices, and termination policies.

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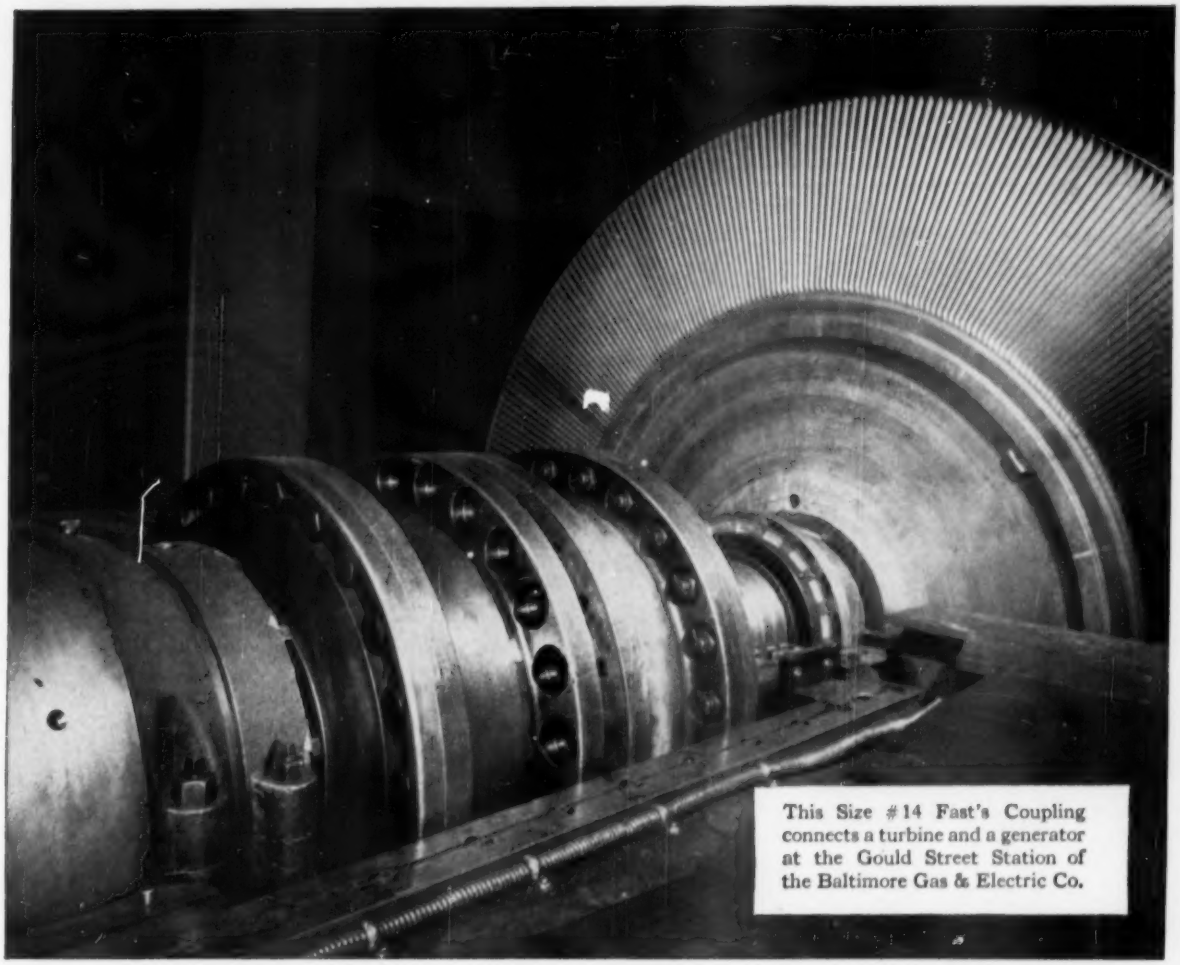
Electric Utility Rate Economics by Russell E. Caywood. First Edition, 1956. 236 pages, 9¼ by 6¼, cloth. Published by McGraw-Hill Book Co., 330 W 42nd St., New York 36, N. Y. Price $10.00.

This is a practical guide to the many economic and technical factors involved in electric utility rate making. It will serve both as a reference and a working tool for rate men of all degrees of experience and will give power salesmen, utility lawyers, and others in the field valuable information on the economics and technology of the industry.

Fundamentals of the electric utility business are described as the foundation for a discussion of such topics as the theoretical



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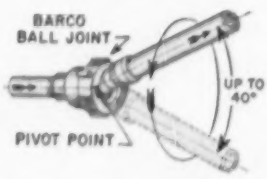
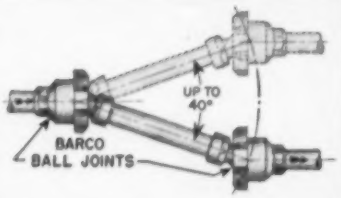
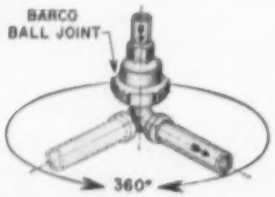


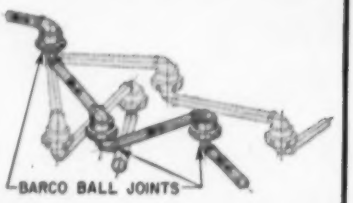
ONE JOINT—Provides for angular motion or positioning of piping in any plane. (Also see below.)



TWO JOINTS—This arrangement provides for piping alignment or simple flexible connection.



ONE JOINT—Allows for full 360° swivel or swing motion, in addition to angular movement shown above.



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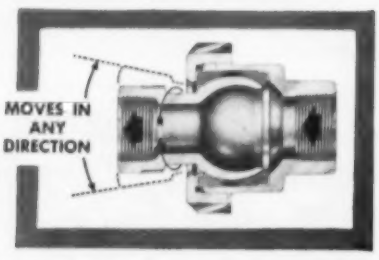

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Engineering Books

continued from page 120

basis of the price structure and the tariff, engineering economics and cost analysis, the rate department, earnings, utility plan, depreciation, and rate of return.

The book points out the great many factors involved in rate making and indicates their interrelationships. Detailed methods and approaches, plus an extensive use of charts, diagrams, tables and check lists, make this book a very useful source of answers to problems in rate making.

* * *

The Oscilloscope at Work by A. Haas and R. W. Hallows. 1956, 171 pages, 8¾ by 5¾ cloth. Published by Philosophical Library, 15 E 40th St., New York 16, N. Y. Price $10.00.

In the past few years, many books have appeared dealing with electronic equipment in which the oscilloscope has been discussed as an incidental part of other apparatus. This present volume deals solely with the cathode-ray oscilloscope. The instrument has such a remarkable versatility and so many uses in many branches of electronics that the user may not always be aware of all its possible applications.

This book, originally published in France, is a practical guide to these applications, though having a special reference to radio and television receivers.

An important feature of the book is the wealth of remarkable oscillograms of great practical value. Over 200 of these, representing more than two years' work, were especially prepared by Alfred Haas, while many new ones have been added for the English adaptation. Numerous circuit drawings and other diagrams have also been provided to clarify the text.

Although the book deals mainly with the uses of the oscilloscope and making correct interpretations of the oscillograms produced, it also contains much valuable information on oscilloscope circuits, instruction and adjustment, while one chapter is devoted to explaining how the instrument can be made to diagnose its own troubles when faults develop.

* * *

Fundamental Formulas of Physics by Donald H. Menzel. First Edition, 1956. 765 pages, 8½ by 6, cloth. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. Price $12.00.

A survey of physical scientists made several years ago indicated the need for a comprehensive reference book on the fundamental formulas of mathematical physics. Such a book, the survey showed, should cover, in addition to basic physics, certain related disciplines, where physics touches upon chemistry, astronomy, meteorology, biology and electronics.

This volume represents an attempt to fill this indicated need. In addition to its pri-

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Engineering Books

continued from page 122

mary function of reference and guide for research, it should have many other uses. A student should find it a handy aid for review of familiar field or for gaining rapid insight into the techniques of new ones. A teacher will find it a useful guide in the broad field of physics. The chemist, the astronomer, the meteorologist, the biologist and the engineer should derive aid from the general sections as well as from the chapters in their specialties.

BOOKS RECENTLY RECEIVED *

Farmstead Wiring Handbook. 47 pages, 8½ by 11 in., paper. Prepared and published by the Industry Committee on Interior Wiring Design, 420 Lexington Ave, Room 2650, New York 17, N. Y. Price 50¢.

* * *

Use and Theory of the Analog Field Plotter. 50 pages, 8½ by 11 in., paper. Prepared and Published by Sunshine Scientific Instruments, 1810 Grant Ave, Philadelphia 15, Penna. Price $2.50.

* * *

Design of Heating and Ventilating Systems, by F. W. Hutchinson. 308 pages, 6¼ by 9¼ in., cloth. Published by Industrial Press, 93 Worth St, New York 13, N. Y. Price $7.00.

* * *

How to Manage Your Meeting, by Harold W. Donahue. 297 pages, 5½ by 8½ in., cloth. Published by Droke House, Indianapolis 6, Indiana. Price $4.00.

* * *

Steels for the User, by R. T. Rolfe. Third Edition, 399 pages, 6 by 9 in., cloth. Published by Philosophical Library, 15 E 40th St, New York 16, N. Y. Price $10.00.

* * *

Ten Year Index to Corrosion, 1945-54, compiled by Norman E. Hamner and J. F. Van der Henst, Jr. 32 pages, 8¼ by 11¼ in. paper. Publication No. 56-10, published by the National Association of Corrosion Engineers, 1061 M & M Bldg, Houston 2, Tex. Price $5.00 to NACE members, all others $7.50.

* * *

Theory and Practice of Lubrication for Engineers, by Dudley D. Fuller. 432 pages, 6 by 9¼ in., cloth. Published by John Wiley & Sons, 440 Fourth Ave, New York, N. Y. Price $10.50.

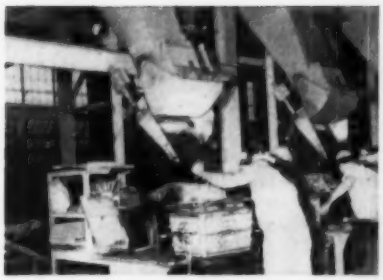
* * *

Diesel Engine Principles & Practice, edited by C. C. Pounder. 848 pages, 580 illustrations, 112 tables, 6 by 8¾ in., cloth. Published by Philosophical Library, New York 16, N. Y. Price $17.50.

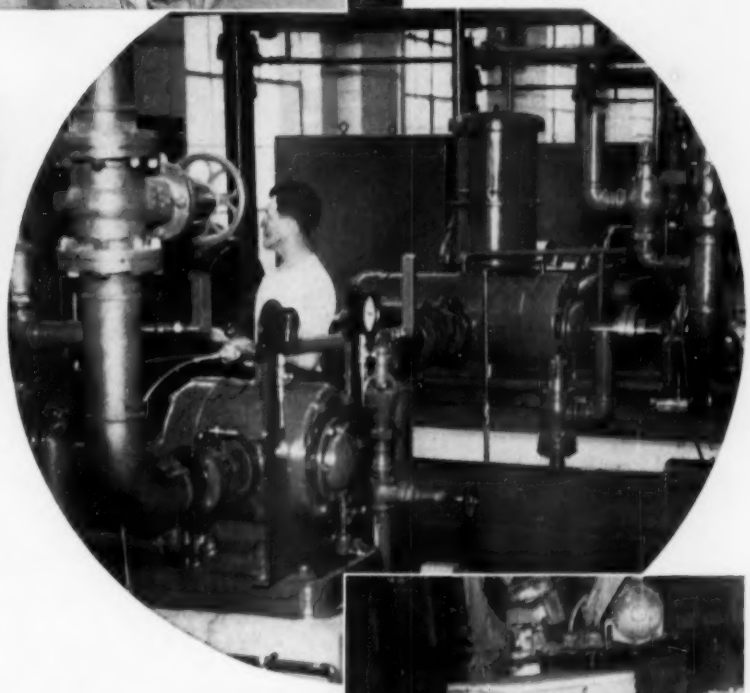
*** We suggest you check with publishers regarding prices, as some of these may have been changed.**

Sand blasting machine, in continuous operation, requires 844 cfm to operate.

Six Fuller Compressors supply a total of 6,800 cfm at 125 psig for plant operations at Textile Machine Works, Reading, Pa.

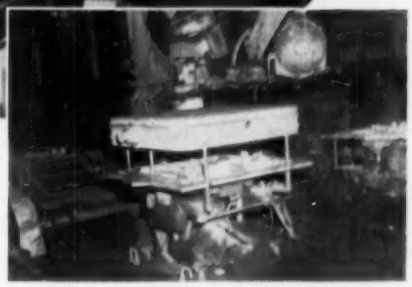


Molders use compressed air to operate hopper-gates, vibrate sand evenly throughout mold, remove pattern plate, squeeze sand in finish, and clean up.



Air-Powered Foundry Operations

. . . at Textile Machine Works



Compressed air lifts flask off pattern plate for removal by hoist or crane.

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This one is closed for cleaning. Back-flushing water enters at side, drains at bottom.

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Engineering Books

continued from page 121

Powder Metallurgy — Now, by F. V. Lenel. 34 pages, 6 by 9 in., paper. Published by the American Society for Testing Materials, 1916 Race St, Philadelphia 3, Penna. Price $1.50.

★ ★ ★

Foundation Engineering, by Rolt Hammond. 192 pages, 6 by 9 in., cloth. Published by Philosophical Library, 15 E 40th St, New York 16, N. Y. Price $10.00.

★ ★ ★

Frequency Response, edited by Rufus Oldenburger. 372 pages, 8½ by 11 in., cloth. Published by the Macmillan Co, 60 Fifth Ave, New York 11, N. Y. Price $7.50.

★ ★ ★

Safety Code for Inspecting, Recharging and Maintaining Portable Fire Extinguishers. 12 pages, 8½ by 11 in., paper. Prepared and published by The Fire Equipment Manufacturers' Association, 813 Clark Bldg, Pittsburgh 22, Penna. Price 50¢.

★ ★ ★

Design of Piping Systems. Second Edition, written by members of the engineering departments of the M. W. Kellogg Co. 365 pages, 11¼ by 8¾ in., cloth. Published by John Wiley & Sons, 440 Fourth Ave, New York 16, N. Y. Price $15.00.

★ ★ ★

Engineers' Job Directory — the Professional Guide to Engineering and Scientific Positions. 87 pages, 11 by 8½ in., paper. Prepared and Published by Decision Inc, Dept 56-C, 105 E Fourth St, Cincinnati 2, Ohio. Price $3.25.

★ ★ ★

Water Hammer — Its Cause, Magnitude, Prevention, by Oscar G. Goldman. 116 pages, 6 by 9 in., cloth. Published by Columbia Graphs, Columbia, Conn. Price $5.00.

★ ★ ★

Specifications and Tests for Electrodeposited Metallic Coatings. 96 pages, 6 by 9 in., paper. Prepared and published by the American Society for Testing Materials, 1916 Race St, Philadelphia 3, Penna. Price $1.85.

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Cast-Brass Solder-Joint Drainage Fittings. 21 pages, 8½ by 11 in., paper. Prepared and published by The American Society of Mechanical Engineers, 29 W 39th St, New York 18, N. Y. Price $1.25.

★ ★ ★

Instruments and Controls Practices for Recent Single Boiler Turbine Reheat Installations. 43 pages, 10¾ by 9½ in., paper. Prepared and published by the Edison Electric Institute, 420 Lexington Ave, New York 17, N. Y. Price $2.00.

★ ★ ★

Modern Surveying for Civil Engineers, by Harold Frank Birchal. Second Edition, 528 pages, 8¾ by 5¾ in., cloth. Published by Philosophical Library, 15 E 40th St, New York 16, N. Y. Price $15.00.

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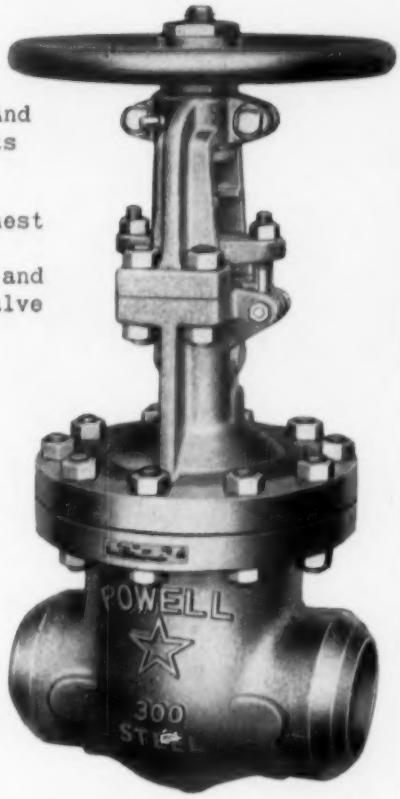

FIG. 3003WE -- Steel O.S. and Y. Gate Valve for 300 Pounds W.S.P.

FIG. 1561WE -- 150-Pound Steel Swing Check Valve

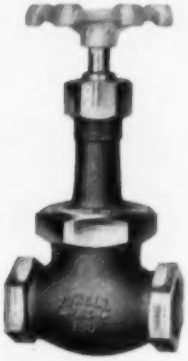

FIG. 2608 -- Bronze "W.S." Full Flow Globe Valve for 200 Pounds W.P.

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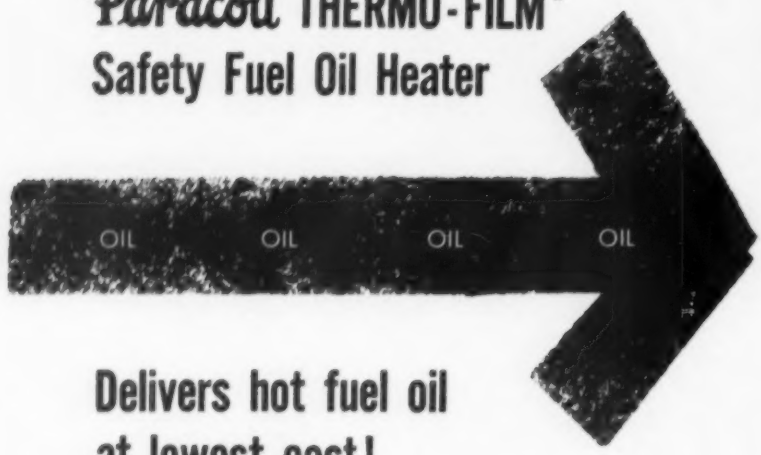

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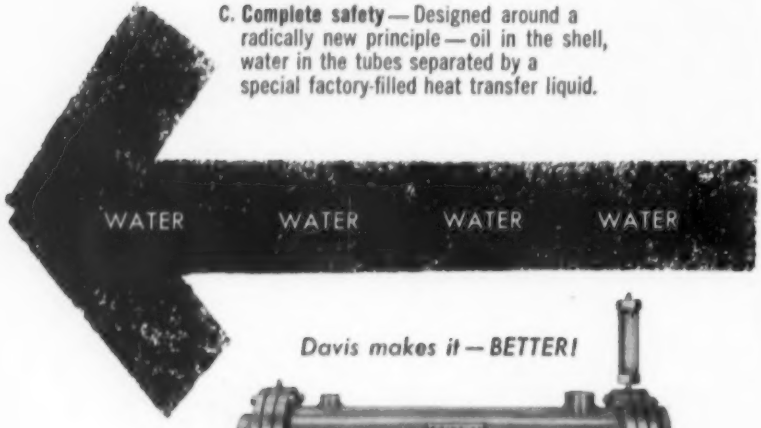

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Engineering Books

continued from page 126

Accident Prevention Manual for Industrial Operations. Third Edition, 1000 pages, 6 by 9 in., cloth. Prepared and published by the National Safety Council, 425 N Michigan Ave, Chicago 11, Ill. Price $11.75.

★ ★ ★

Safety in Industry — an Introduction to the Protection of Personnel, by D. I. Macfarlane. 71 pages, 6 by 9 in., cloth. Published by Philosophical Library, 15 E 40th St, New York 16, N. Y. Price $6.00.

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Mechanical Engineering Practice — a Laboratory Reference Text, by Charles F. Shoop and George L. Tuve. 471 pages, 9¼ by 6¼ in., cloth. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y. Price $7.00.

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Engineering in History, by Richard Shelton Kirby, etal. 529 pages, 9¼ by 6¼ in., cloth. Published by McGraw-Hill Book Co. Price $8.50.

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Electric Generation — Hydro, Diesel, and Gas-Turbine Stations, edited by Bernhardt G. A. Skrotski. 458 pages, 9¼ by 6¼ in., cloth. Published by McGraw-Hill Book Co. Price $8.50.

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American Standard Code for Elevators, Dumbwaiters and Escalators. 290 pages, 7¾ by 5¼ in., paper. Prepared and published by The American Society of Mechanical Engineers, 29 W 39th St, New York 18, N. Y. Price $3.50.

★ ★ ★

Review of Current Research and Directory of Member Institutions. 352 pages, 8¾ by 5¾ in., paper. Prepared by the Engineering College Research Council of the American Society for Engineering Education. Copies may be ordered from: Renato Contini, Secretary, Engineering College Research Council New York University, New York 53, N. Y. Price $2.00.

★ ★ ★

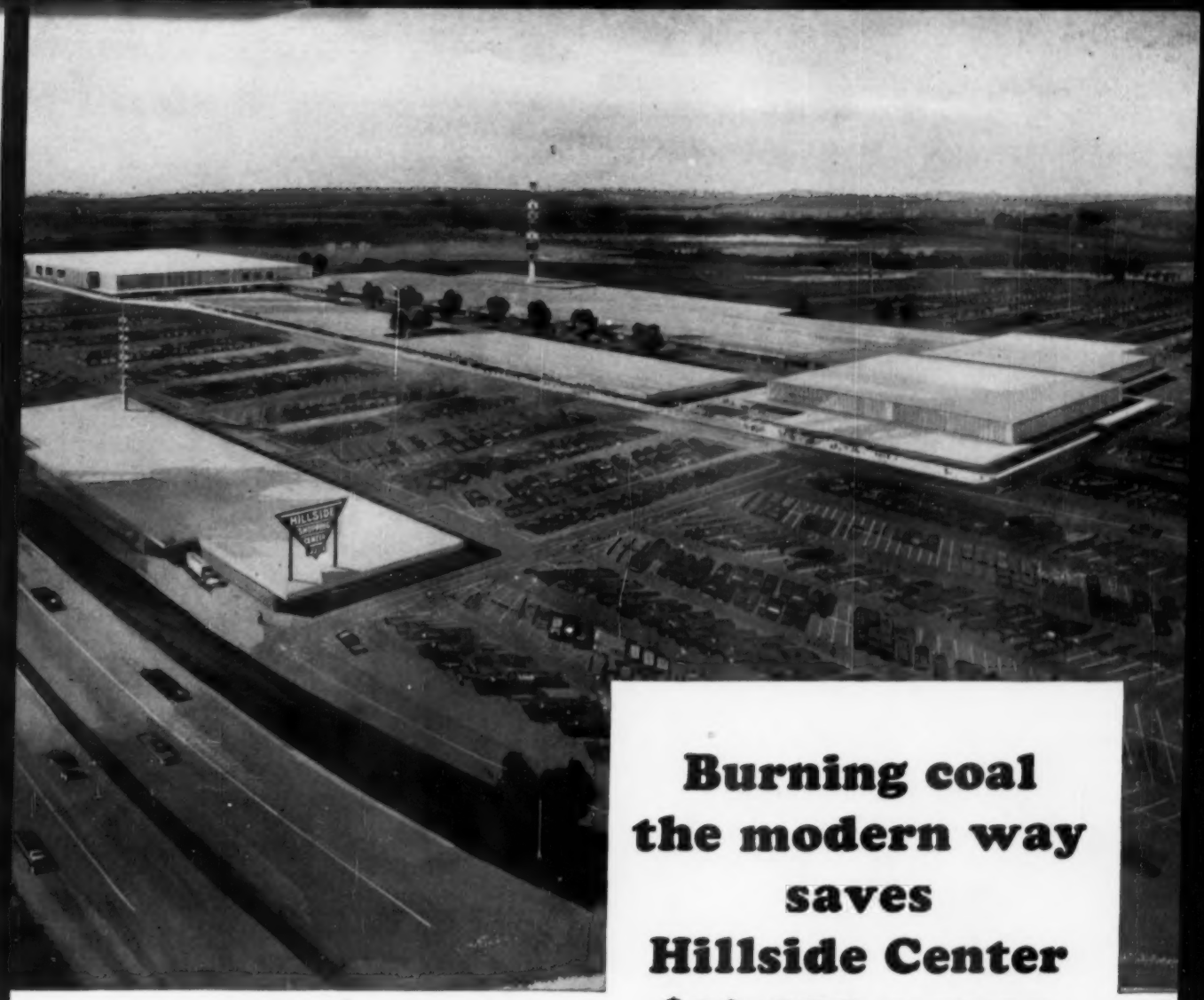
Instruments for the Study of Atmospheric Pollution. Second Edition, 1956. 25 pages, 8¼ by 11 in., paper. Prepared and published by ASME Committee on Air Pollution Controls, 29 W 39th St, New York 18, N. Y. Price $2.00.

★ ★ ★

ASTM Standards on Metallic Electrical Conductors, 1955. 298 pages, 6 by 9 in., paper. Sponsored by ASTM Committee B-1 on Wires for Electrical Conductors, and published by the American Society for Testing Materials, 1916 Race St, Philadelphia 3, Penna. Price $3.50.

★ ★ ★

Electronics in Industry, by George M. Chute, Second Edition, 431 pages, 9¼ by 6¼ in., cloth. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y. Price $7.50.



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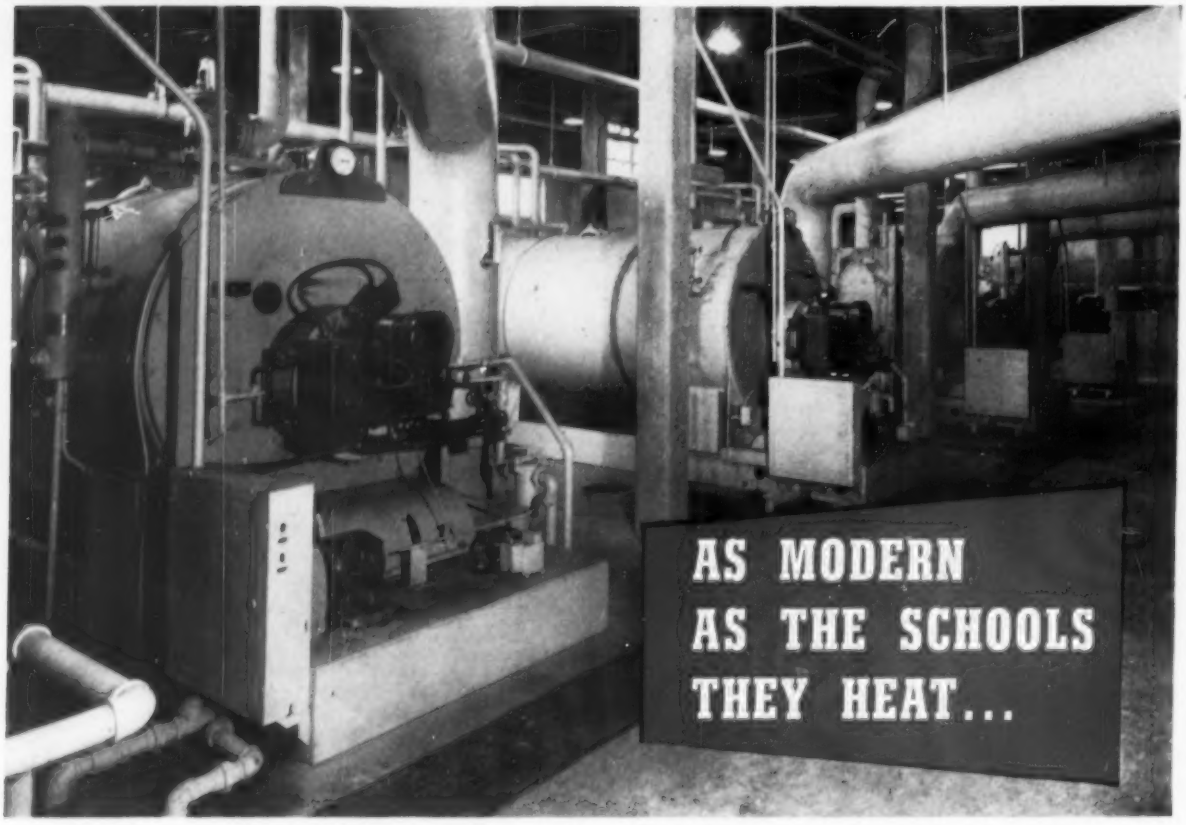

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REFRACTORIES, INSULATIONS

201 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from — 400 F to 3000 F. Johns-Manville.

202 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

203 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-p illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

BOILERS, GENERATORS

204 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table with specifications. Combustion Engineering, Inc.

205 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

206 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

207 Boiler Family — Bulletin B-3300-A describes a wide range of company's heating and power boilers and includes photos and cutaway views showing construction features. A list of bulletins

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101	102	103	104	105	106	107
108	109	110	111	112	113	114
115	116	117	118	119	120	121
122	123	124	125	126	127	128
129	130	131	132	133	134	135
136	137	138	139	140	141	142
143	144	145	146	147	148	149
150	151	152	153	154	155	156
157	158	159	160	161	162	163
164	165	166	167	168	169	170
171	172	173	174	175	176	177

Catalog Library

201	202	203	204	205	206	207	208	209	210	211
212	213	214	215	216	217	218	219	220	221	222
223	224	225	226	227	228	229	230	231	232	233
234	235	236	237	238	239	240	241	242	243	244
245	246	247	248	249	250	251	252	253	254	255
256	257	258	259	260	261	262	263	264	265	266
267	268	269	270	271	272	273	274	275	276	277
278	279	280	281	282	283	284	285	286	287	288
289	290	291	292	293	294	295	296	297	298	299

Equipment

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40
41	42	43	44

Advertised Products and Services

501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521
522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542
543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563
564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584
585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605

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on the various types of boilers is included. Titusville Iron Works Div., Struthers Wells Corp.

208 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of the units and design features are included. Foster Wheeler Corp.

209 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

210 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

211 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

FUEL BURNING EQUIPMENT

212 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

213 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

214 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

TUBING AND ACCESSORIES

215 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combat-

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13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32
33	34	35	36
37	38	39	40
41	42	43	44

101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177																							

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201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250
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626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650
651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675
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The basis of Jewett's exceptional durability is its construction of high-quality long fibre asbestos yarn with fine copper wire inserts. This yarn is braided over a lead ribbon core and formed square. Style 10 is treated with a heavy bodied, heat-resisting lubricant which won't bleed in valve stem service. Furnished graphited in coil or ring form in sizes from ⅛″ up.

. . . for superheated steam and gases to 900F *it's J-M High Temperature*

When valves are operating in high temperature service, your best packing choice is Johns-Manville High Temperature Style 398. It retains its resilience, holds a tight, lasting seal against superheated steam and dry gases under elevated pressures and temperatures up to 900F.

To obtain this high sealing efficiency, Johns-Manville braids asbestos yarn of high purity over a plastic core of special heat resistant composition. For extra strength, the yarn is reinforced with tough heat and corrosion resistant Monel wire. The packing is formed square and then lubricated with mica. Furnished in ring, coil and spiral form in sizes ¼″ to 1″.

Your local J-M distributor carries full stocks of Jewett, High Temperature and other packings. Call him today or write Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

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158 OBSERVER HIGHWAY
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ing them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

216 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

217 Tube Tools — Eight-pp Bulletin 58 describes advantages and application of company's line of tube cleaners, tube expanders and maintenance tools, including drills, brushes, accessory and specialty tools. Photos are included as well as size and selection data. Airetool Mfg. Co.

218 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

219 Tube Expanders — Catalog 88, 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving sizes. Thomas C. Wilson, Inc.

WATER CONDITIONING

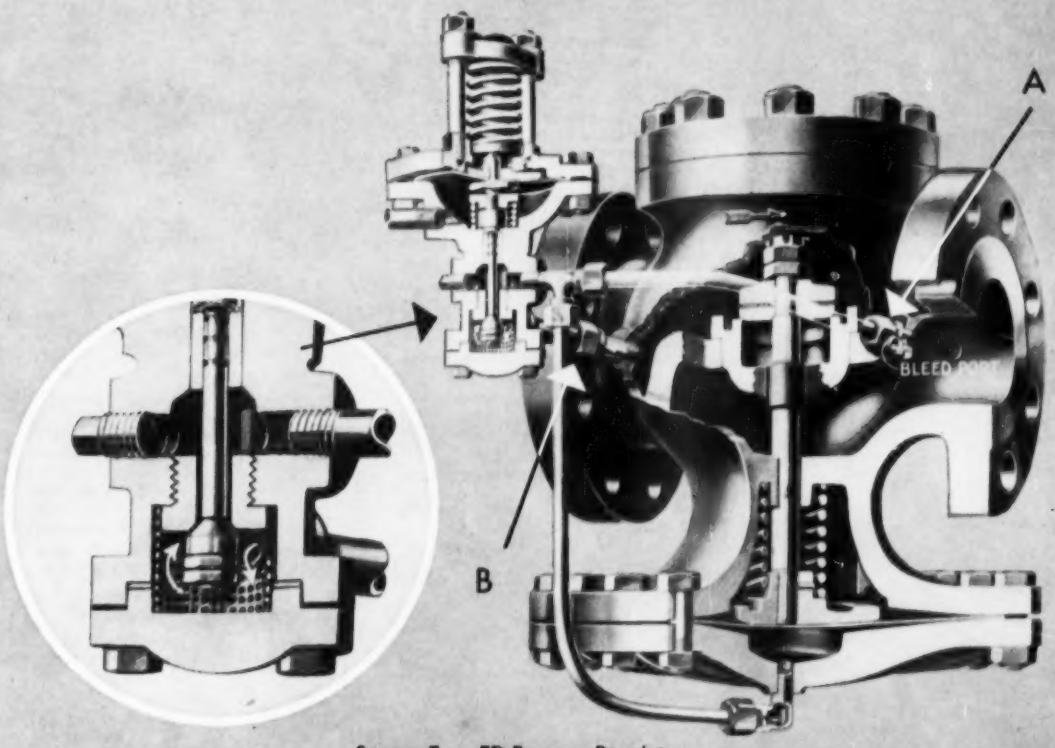
220 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

221 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or monobed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

222 For Industrial Water Softening — Greensand, zeolite and resinous exchange water softeners are described in 8-pp Form 8-105. Discusses features and applications of each of these basic types and illustrates some installations. Includes capacity data and general specifications.

VALVE TIPS:

Advantages of External Pilots in Automatic Regulating Valves



Spence Type ED Pressure Regulator

"Maintenance-free, trouble-free, install-and-forget." They're all pretty phrases, but every engineer knows from experience they don't apply to regulating valves. Any valve designed to control temperatures or pressures within tight limits can be affected by dirt or other foreign matter in steam lines.

One advantage of the external pilot mounting shown above is simplified maintenance. Trouble shooting is faster, downtime is reduced, and tempers don't take such a beating. Here's why:

If trouble develops, it's easy to find out if it's in the pilot or the main valve. Just remove the tubing bend at **A**. A simple test, without any instruments or other equipment, shows where the trouble is.

If the trouble is in the pilot, you can remove it by disconnecting the unions at B. There's no need to take the main valve out of the line.

The quickest way to get the regulator functioning again is to install a spare pilot. This is easy — and in the Spence design it's not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves. There's no need to stock an expensive inventory of pilots for each main valve size.

In the enlarged sectional drawing above, you can see how the strainer, seat and disc of the pilot are readily accessible by removing the blind flange.

If the trouble is in the main valve, here again inspection is easy. If there's dirt in the steam line, it may clog the bleed port or restriction orifices. In the Spence design these can be inspected and cleaned by merely removing the tubing connections. The seat and disc of the main valve can also be inspected easily by removing the top flange.

These maintenance advantages, plus other advanced design features, are available for a wide range of regulating applications. For information on Spence's wide range of different automatic regulating valves, write for your copy of Bulletin 1005.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

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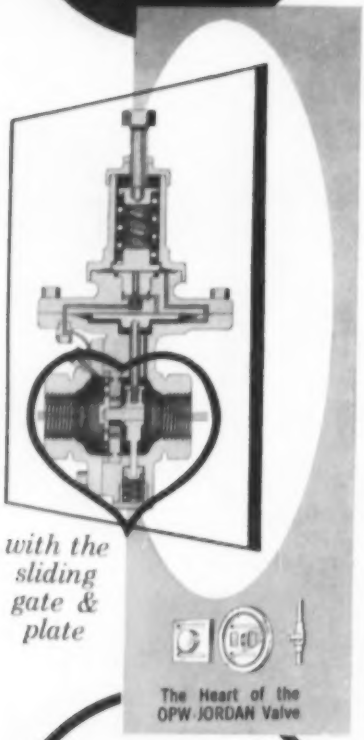
OPW-JORDAN
pilot-operated
pressure reducing VALVE



with the sliding gate & plate

The Heart of the OPW-JORDAN Valve

UTMOST SENSITIVITY AND ACCURACY OF REGULATION

Compensates for changes in inlet pressures and downstream demands

- DEAD END SHUT-OFF
- WIRE DRAWING MINIMIZED OR ELIMINATED
- SELF-LAPPING SEAT
- ELIMINATES VALVE CHATTER

Simplicity of sliding gate design eliminates causes of "down-time" commonly associated with pilot-operated valves. The No. 1160 offers a different and improved way to accurate control with all of the desired sensitivity of response.

For more facts, write for Bulletin J-1160.

JORDAN CORPORATION
Division of OPW Corporation
6013 WIEHE ROAD
CINCINNATI 13, OHIO
ELMHURST 1-1352

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Also describes and pictures controls for water softeners, pressure filters and deionizers. Illinois Water Treatment Co.

223 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising the pH value of the condensate. The Bird-Archer Co.

224 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

226 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

227 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

COAL, ASH HANDLING

228 Tractor Shovel — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

230 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

231 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

VALVES, TRAPS, PIPING AND ACCESSORIES

233 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

234 Check Valves — Twenty-pp Catalog 30 presents company's line of

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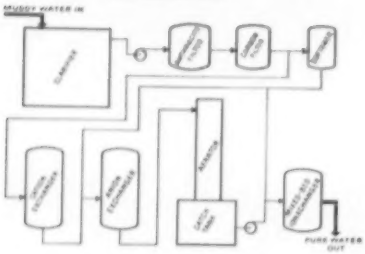

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tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

235 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

237 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

238 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve — fluid, temperature, pressure, size and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

240 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

241 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

Postage-free cards for ordering catalogs are on page 132. You may also use the cards to order literature mentioned in the ads.

243 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

244 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving

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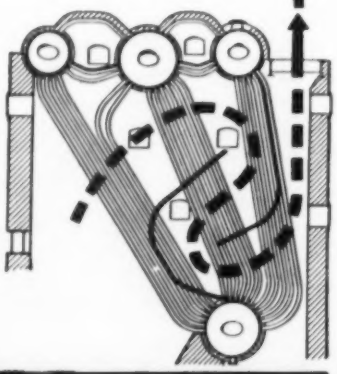

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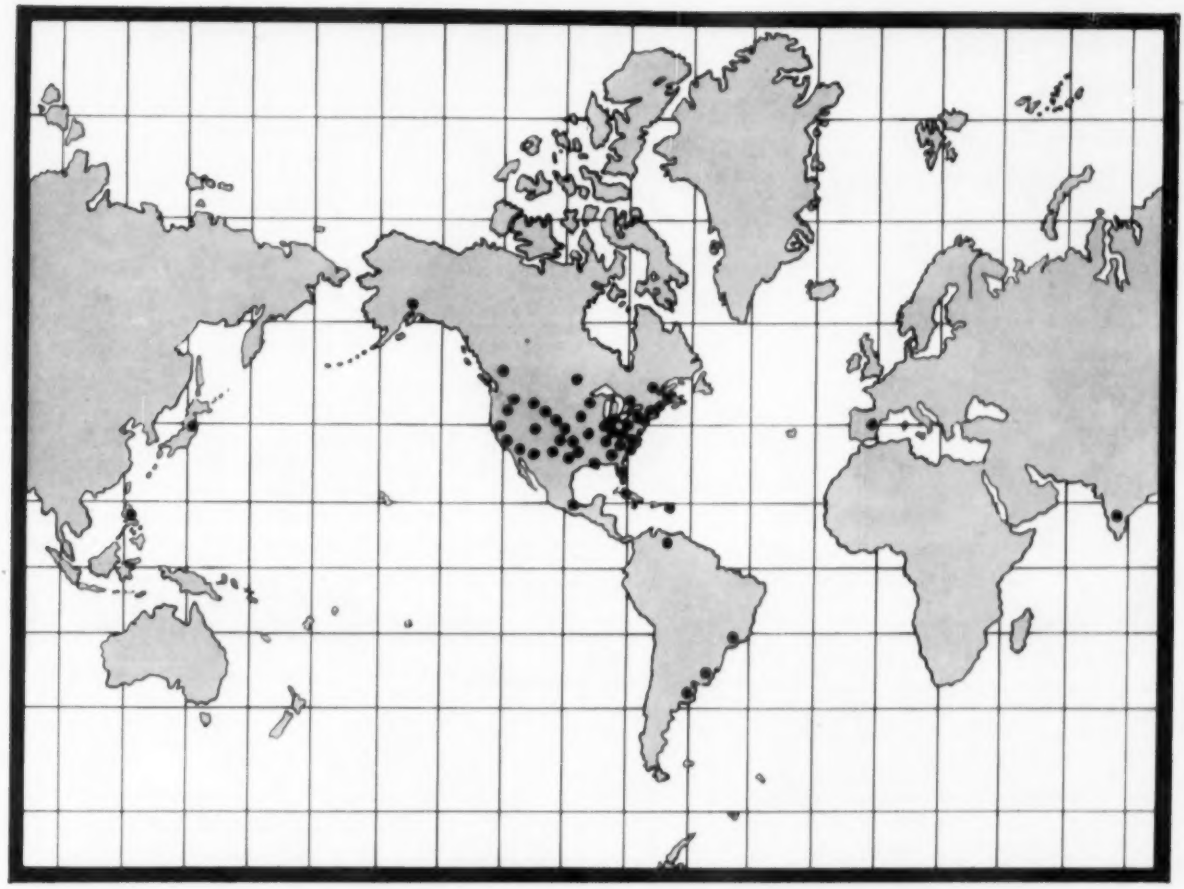

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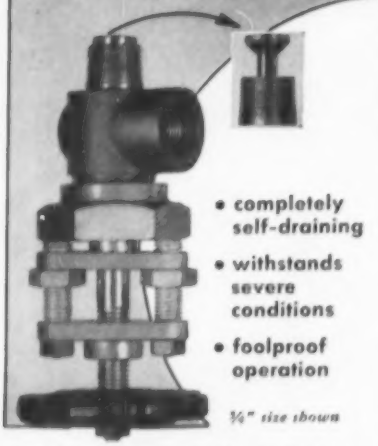

- completely self-draining
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The new Jerguson No. 23 Drain or Sampling Valve is completely self draining, for the valve stem seats on the outside of the valve body. It is ideal for installations where it is desirable to have the valve seat inside the wall of a vessel in order to prevent the typical condition of liquid remaining in the nipple and valve inlet.

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Available in sizes from ¾" to 2" N.P.T. ¾" and 1" sizes are recommended for pressures of 4000 lbs. @ 100° F. and 1000 lbs. @ 750° F.; 1¼, 1½ and 2" sizes are recommended for 600 lbs. @ 100° F. and 250 lbs. @ 750° F. Optional features include construction with additional outlet for such uses as a steaming out connection and with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

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physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

247 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

248 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

ELECTRICAL EQUIPMENT

251 Testing Instruments — Bulletin 19-56, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric tests sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

252 Industrial Systems — Bulletin GED-3039, 48 pp, gives information on distribution system planning. Features, advantages, application, operation and other data on system-engineered equipment for industrial power distribution, including switchgear, unit substations, switchboards, transformers, busways, wire and cable, conduit products, voltage regulators, capacitors, circuit breakers, safety switches, panelboards, controls, motor controls, motors, turbines, rectifiers, and wiring devices are covered. General Electric Co.

254 High-Power Batteries — Bulletin CP-538.55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

PACKINGS, SEALS

257 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

258 Mechanical Seals — Bulletin S-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service and application information, installations and engineering details. Crane Packing Co.

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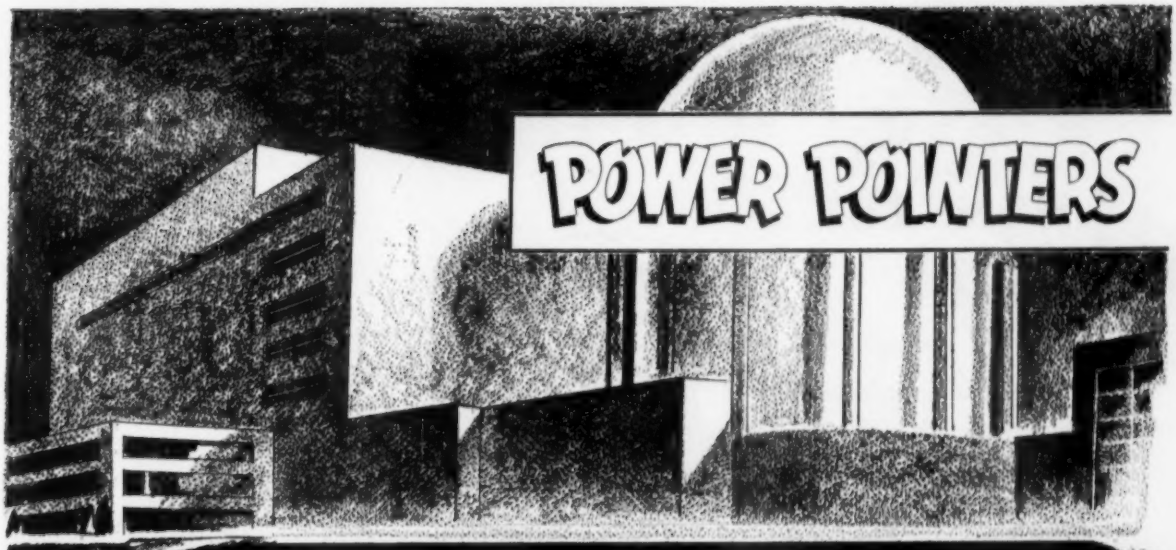

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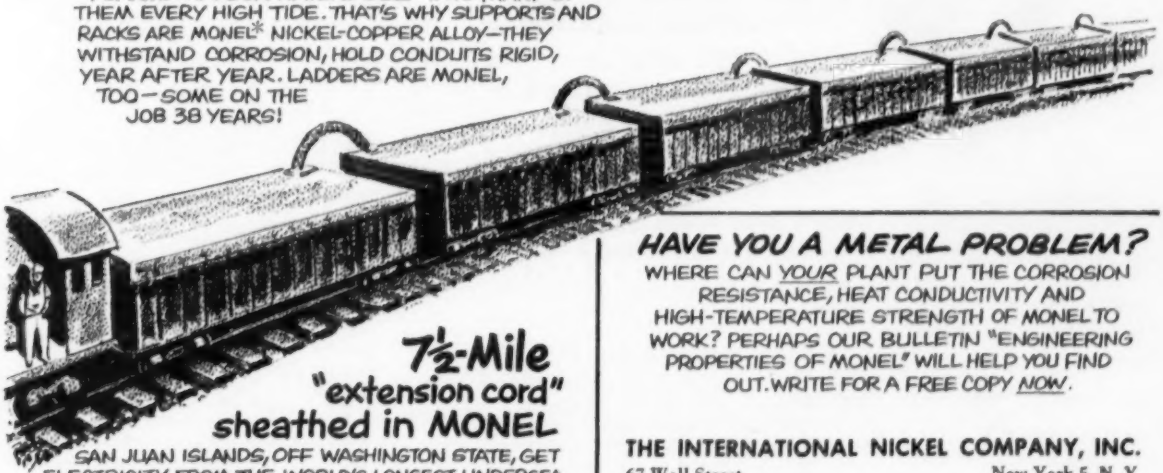

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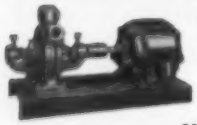

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INSTRUMENTS, CONTROLS

261 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

262 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

263 Instrument Panels — Power and process plants can choose instrument and control panels to meet individual specifications from six standard designs described in 16-pp Product Specification G71-7. Complete specifications are furnished, as well as information on supports and mountings for tubes, wires and equipment, instrument mounting dimensions, and dimensions of standard instrument and control panels. Bailey Meter Co.

265 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

266 Solenoid Pilots — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, gas and liquid service. Schematic diagrams of typical applications are given. Spence Engineering Co., Inc.

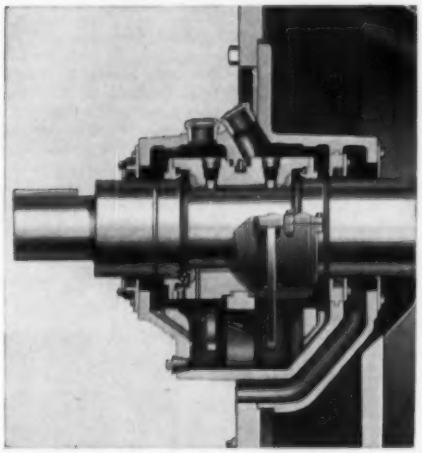
267 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

268 D-C Amplifier — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier and describes some applications. Hagan Corp.

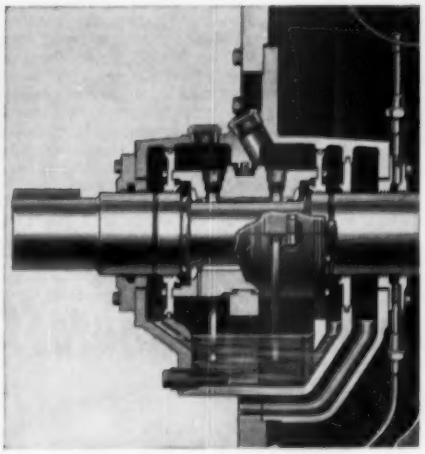
269 Ideas on Push Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

NEW Bearing Design Means Better Motor Performance

Allis-Chalmers capsule-type sleeve bearings now perfected for complete motor line



Standard capsule-type sleeve bearing



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Drip-proof or splash-proof cage motor

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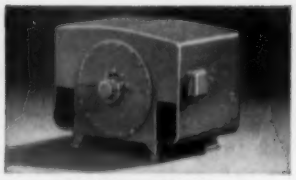
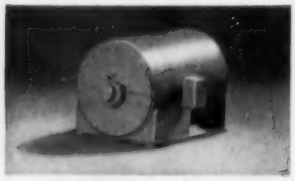
High speed cage motor



Weather-protected motor



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MECHANICAL POWER TRANSMISSION

270 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multi-color tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

271 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

272 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

OTHER EQUIPMENT

273 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

274 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

275 Corrosion Control — Treatment of industrial equipment to control corrosion cannot be a hit-and-miss proposition cautions this 6-pp folder. Examples are given of optimum control measures that may avoid costly, unsound treatment procedures, including minor physical or operating changes. Hall Laboratories, Inc.

276 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

277 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet it tended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

278 Heat Transfer Apparatus — Condensed Bulletin HT-1 highlights representative products in company's line of heat transfer equipment. Includes oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes, coils. Schutte and Koerting Co.

279 Solids Handling Pumps — Bulletin 121-A, 8 pp, describes a complete line of non-clog pumps for handling solids in suspension. Included are vertical, horizontal and close-coupled types used to handle liquid components of industrial processes, industrial waste, and for such pumping applications as water supply, drainage and sewage handling. Specifications are included. Aurora Pump Div., The New York Air Brake Co.

280 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved, in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

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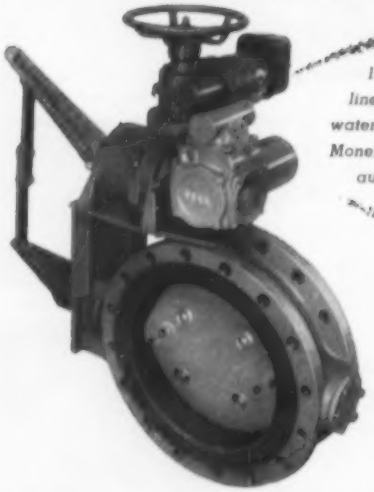

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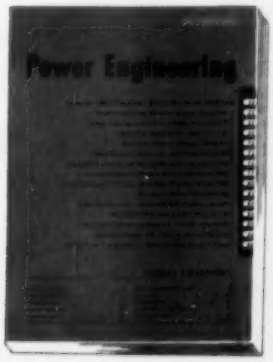

ADVERTISERS' INDEX

AIR PREHEATER CORP., INC. ..... *
Agency—G. M. Basford Company
AIRETOOL MFG. CO. ..... *
Agency—Harry M. Miller, Inc.
ALLIS-CHALMERS MFG. CO. 22–23, 61, 143
Agency—Compton Advertising Inc.
ALLIS-CHALMERS MFG. CO. (TRACTOR DIV.) ..... *
Agency—Bert S. Gittins Advertising
AMERICAN BLOWER CORP. 10–11
Agency—Brooke, Smith, French & Dorrance, Inc.
AMERICAN BRASS CO. ..... *
Agency—Kenyon & Eckhardt Inc.
AMERICAN CHAIN & CABLE CO., INC. 116
Agency—Reincke, Meyer & Finn, Inc.
AMERICAN CHIMNEY CORP. 144
AMERICAN ENGINEERING CO. ..... *
Agency—Hazard Advertising Co.
AMERICAN GILSONITE CO. ..... *
Agency—Fred Wittner Advertising
AMERICAN PULVERIZER CO. 118
Agency—Batz-Hodgson-Neuwoehner
ANDERSON CO., V. D. 114
Agency—Will Inc.
ARMSTRONG MACHINE WORKS 7
Agency—Russell T. Gray, Inc.
ATOMICS INTERNATIONAL 36
Agency—Batten, Barton, Durstine & Osborne, Inc.
AURORA PUMP DIVISION, THE NEW YORK AIR BRAKE CO. 142
Agency—Fred A. Hanrahan Advertising Agency

BABBITT STEAM SPECIALTY CO. ..... *
Agency—George T. Metcalf Co.
BABCOCK & WILCOX CO., THE (BOILER DIV.) 30–31
Agency—O. S. Tyson and Co., Inc.
BABCOCK & WILCOX CO. (REFRACTORIES DIV.) 45
Agency—Michel-Cather, Inc.
BAILEY METER COMPANY 34
Agency—Fuller & Smith & Ross, Inc.
BALDWIN-HILL CO. 33
Agency—Eldridge, Inc.
BALTIMORE & OHIO RR. 107
Agency—Richard A. Foley, Inc.
BARCO MANUFACTURING CO. 122
Agency—Armstrong Advertising Agency
BECKMAN, ARNOLD O., INC. ..... *
Agency—Dozier Eastman & Co.
BELMONT PACKING & RUBBER CO., THE ..... *
Agency—The Michener Co.
BETZ, W. H. & L. D. 101
Agency—The Michener Co.
BIDDLE CO., JAMES G. 112
Agency—The Roland G. E. Ullman Org.
BIRD-ARCHER CO., THE ..... *
Agency—The Roland G. E. Ullman Org.
BITUMINOUS COAL INSTITUTE 129
Agency—VanSant Dugdale & Co., Inc.
BOILER ENGINEERING & SUPPLY CO. ..... *
Agency—William Jenkins Advertising
BOWSER, INC. ..... *
Agency—Willis S. Martin Co.
BRIDGEPORT BRASS CO. ..... *
Agency—Hazard Advertising Co., Inc.
WM. BROS. BOILER & MFG. CO. ..... *
Agency—The Alfred Colle Co.
BRUNER CORPORATION 119
Agency—The Saxton Agency
BUSSMANN MFG. CO. 18–19

C & D BATTERIES 60
Agency—John T. Hall & Co.
CAMBRIDGE INSTRUMENT CO., INC. 147
Agency—E. M. Freystadt Associates, Inc.
CHAPMAN VALVE MFG. CO., THE ..... Inside Back Cover
Agency—Sutherland-Abbott
CHESAPEAKE & OHIO RAILROAD 123
Agency—Robert Conahay, Inc.
CLYDE IRON WORKS, INC. ..... *
Agency—Graves and Associates, Inc.
COCHRANE CORPORATION ..... *
Agency—Hening & Co., Inc.
COMBUSTION ENGINEERING, INC. 12–13
Agency—G. M. Basford Company
CONDENSER SERVICE AND ENGINEERING 134
Agency—Diener & Dorskind, Inc.
COOK, C. LEE, CO. 59
Agency—Doe-Anderson Advertising Agency
COPES-VULCAN DIV., BLAW-KNOX CO. ..... *
Agency—Ketchum, MacLeod & Grove Inc.
CRANE CO. 55
Agency—The Buchen Company
CRANE PACKING CO. 61
Agency—Symonds, MacKenzie & Co., Inc.

DAVIS ENGINEERING CORPORATION 128
Agency—Howard A. Harkavy, Inc.
DEARBORN CHEMICAL CO. 26
Agency—The Buchen Co.
DE LAVAL SEPARATOR CO., THE ..... *
Agency—Donahue & Co., Inc.
DE LAVAL STEAM TURBINE CO. 5
Agency—Michel-Cather, Inc.
DETROIT STOKER COMPANY ..... *
Agency—Witte & Burden
DIAMOND POWER SPECIALTY CORP. 28–29
Agency—Witte & Burden
DODGE MANUFACTURING CO. ..... *
Agency—Lamport, Fox, Prell & Dolk, Inc.

EDISON, THOMAS A. ..... *
Agency—Gaynor, Colman, Prentis & Varkey, Inc.
EDWARD VALVES, INC. 35, 37
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.
ELECTRICAL ENGINEERS EQUIPMENT CO. ..... *
Agency—Hollander & Weghorn
ELLIOTT CO. 126
Agency—Downing Industrial Advertising, Inc.
ELLISON DRAFT GAGE CO. ..... *
Agency—Tri State Advertising Co., Inc.
ENGINEER CO., THE 138
Agency—Michel-Cather, Inc.
ERIE CITY IRON WORKS 30–31
Agency—Davies and McKinney
EVERLASTING VALVE CO. ..... *
Agency—Michel-Cather, Inc.

FAIRMOUNT CHEMICAL CO., INC. 140
FELT PRODUCTS MFG. CO. ..... *
Agency—VanAuken, Ragland & Stevens
FLEXONICS CORP. ..... *
Agency—Russell T. Gray, Inc.
FOSTER CO., BENJAMIN ..... *
Agency—Elmer P. Cook Associates
FOSTER WHEELER CORP. 24–25, 63
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.
FULLER CO. 125
Agency—O. S. Tyson & Co., Inc.

GENERAL COAL CO. 147
Agency—The Aitken-Kynett Co.
GENERAL ELECTRIC CO. ..... *
Agency—G. M. Basford Co.
GOODALL RUBBER CO. ..... *
Agency—George C. Taylor Advertising
GRAVER WATER CONDITIONING 2
Agency—Trade Method Advertising

HAGAN CORPORATION ..... *
Agency—Ketchum, MacLeod & Grove, Inc.
HALL LABORATORIES, INC. 109
Agency—Ketchum, MacLeod & Grove, Inc.
HENSLEY COMPANY 142
Agency—Knox Advertising Agency
HILLS McCANNA CO. ..... *
Agency—Waldie & Briggs, Inc.
PAUL B. HUYETTE CO., Inc. ..... *

ILLINOIS WATER TREATMENT CO. 138
Agency—Cummings, Brand & McPherson
INFILCO INC. 148
Agency—Willard C. Gregory & Co.
INTERNATIONAL NICKEL COMPANY, INC., THE 141
Agency—Marschalk & Pratt Co. Division of McCann-Erickson, Inc.

JERGUSON GAGE & VALVE 140
Agency—Roy Elliott Co.
JOHNS-MANVILLE 133
Agency—J. Walter Thompson Company
JOHNSON-MARCH CORP. ..... *
Agency—Beaumont, Heller & Sperling, Inc.
JORDAN CORP. 136
Agency—Hashnie Corp.

E. KEELER CO. ..... *
Agency—Charles E. Williams Advertising
KIRK & BLUM MFG. CO. 46
Agency—The S. C. Baer Co.
KOPPERS CO., INC. 121
Agency—VanSant Dugdale & Co., Inc.
KOR CORPORATION ..... *
KULJIAN CORP. ..... *
Agency—The Roland G. E. Ullman Org.

LACLEDE CHRISTY CO., DIVISION H. K. PORTER CO., INC. ..... *
Agency—St. Georges and Keyes, Inc.
LADISH CO. ..... *
Agency—The Cramer Krasselt Co.
LESLIE CO. ..... *
Agency—Reid, Decker & Stocki, Inc.

MANNING, MAXWELL & MOORE, INC. ..... *
Agency—Fuller & Smith & Ross, Inc.
MARLEY CO., THE 48
Agency—Valentine Radford Advertising
MEAD-MORRISON DIVISION, McKIERNAN-TERRY CORP. 111
Agency—Michel-Cather, Inc.
MERIAM INSTRUMENT CO., THE ..... *
Agency—Thomas R. Sundheim
MILTON ROY CO. 47
Agency—The Aitkin-Kynett Co.
MORTON SALT CO. ..... *
Agency—Needham, Louis & Brorby, Inc.

NAGLE PUMPS, INC. ..... *
Agency—Tri State Advertising Co., Inc.
NATIONAL AIROIL BURNER COMPANY, INC. ..... *
Agency—R. E. Lovekin Corp.
NATIONAL ALUMINATE CORPORATION 40
Agency—Armstrong Advertising Agency
NEW ENGLAND CARBIDE TOOL CO. 136
Agency—Callaway Association
NIAGARA BLOWER COMPANY ..... *
Agency—The Moss-Chase Company
NORTH AMERICAN MOGUL PRODUCTS CO., THE 53
Agency—Ritchie & Sattler, Inc.

OHIO INJECTOR CO. ..... Inside Front Cover
Agency—Fuller & Smith & Ross, Inc.
OLD BEN COAL CO. 137
Agency—W. S. Kirkland Advertising

PEABODY ENG. CORP. ..... *
Agency—Richard LaFond Adv. Inc.
PERMUTIT CO., THE 14–15
Agency—Cunningham & Walsh, Inc.
PHILADELPHIA PUMP & MACHINERY CO. ..... *
Agency—The Michener Co.
PITTSBURGH PIPING & EQUIPMENT CO. 1
Agency—W. S. Hill Co.
POWELL VALVES 127
Agency—The Ralph H. Jones Co.
PRAT-DANIEL CORP. ..... *
Agency—Hening & Co.
PRATT, HENRY ..... *
Agency—Hollander & Weghorn Advertising Agency
PREFERRED UTILITIES MFG. CORP. ..... *
Agency—Spooner & Kriegel

RAYBESTOS-MANHATTAN, INC. 120
Agency—Gray & Rogers
RAYTHEON MANUFACTURING CO. ..... *
Agency—Donahue & Coe, Inc.
REFRACTORY & INSULATION CORP. 62
Agency—Spooner & Kriegel
RELIANCE GAUGE COLUMN COMPANY 44
Agency—Carr Liggett Advertising Inc.
REPUBLIC FLOW METERS CO. ..... *
Agency—Stoetzel & Associates, Inc.
RESEARCH-COTTRELL, INC. 38–39
Agency—Michel-Cather Inc.
REVERE COPPER & BRASS, INC. ..... *
Agency—St. Georges & Keyes, Inc.
RHOPAC, INC. ..... *
Agency—Merchandising Advertisers, Inc.
RIC-WIL, INC. 139
Agency—Ritchie & Sattler, Inc.
RILEY STOKER CORPORATION 16–17
Agency—Seth R. Martin
ROCKWELL CO., W. S. 144
Agency—Spooner & Kriegel
ROSS HEAT EXCHANGER DIVISION ..... *
Agency—Harold Warner Co.
ROTHLAN CORP. ..... *
ROTO DIV. OF ELLIOTT CO. 64
Agency—Jos. Vogel & Co.
R-P & C VALVE DIVISION, AMERICAN CHAIN & CABLE CO., INC. 116
Agency—Reincke, Meyer & Finn, Inc.

SARCO COMPANY, INC. 57
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.
SIMS PUMP VALVE CO., INC. ..... *
Agency—Tarrill Belknap Marsh Associates
SINCLAIR REFINING CO. 103
Agency—Morey, Humm, & Warwick, Inc.
SOUTHERN COAL CO., INC. ..... *
Agency—Hitchcock & Becker Advertising
SPENCE ENGINEERING CO. 135
Agency—Michel-Cather, Inc.
STANDARD OIL CO. (INDIANA) 113
Agency—D'Arcy Advertising Co.
STEARNS MAGNETIC PRODUCTS 49
Agency—Bert S. Gittins Advertising, Inc.
STEPHENS-ADAMSON MFG. CO. 27
Agency—Connor Associates, Inc.
STICKLE STEAM SPECIALTIES CO. ..... *
Agency—W. H. Rohr, Jr.
STONE & WEBSTER ENGINEERING CO. 33
Agency—Harold Cabot & Co., Inc.
STRUTHERS WELL CORP. ..... *
Agency—Downing Industrial Advertising Inc.
STURTEVANT MILL CO. ..... *
Agency—F. P. Walther Jr. & Associates, Inc.
SUPERIOR COMBUSTION INDUSTRIES, INC. 130
Agency—Charles H. Davis

TAYLOR & CO., W. A. ..... *
Agency—Emery Advertising Corporation
THE TERRY STEAM TURBINE CO. 105
Agency—Gassaway Advertising Agency
TEXAS CO., THE ..... Back Cover
Agency—G. M. Basford Co.

UNION IRON WORKS 115
Agency—Harold Warner Co.
UNIVERSAL ATLAS CEMENT CO. 117
Agency—Batten, Barton, Durstine & Osborn, Inc.

VOGT MACHINE CO., HENRY 43
Agency—Forsan, Huff & Northlich

WESTERN CHEMICAL COMPANY 124
Agency—Carter Advertising Agency, Inc.
WESTERN PRECIPITATION CORP. ..... *
Agency—Dozier Eastman & Co.
WICKES BOILER CO. 20–21
Agency—Price, Tanner & Willox, Inc.
WILLIAMS GAUGE CO. ..... *
Agency—Downing Industrial Advertising, Inc.
WILSON, INC., THOMAS C. ..... *
Agency—Michel-Cather, Inc.
WORTHINGTON CORPORATION ..... *
Agency—Needham, Louis & Brorby, Inc.

YARNALL-WARING COMPANY 8–9, 66
Agency—The Michener Co.

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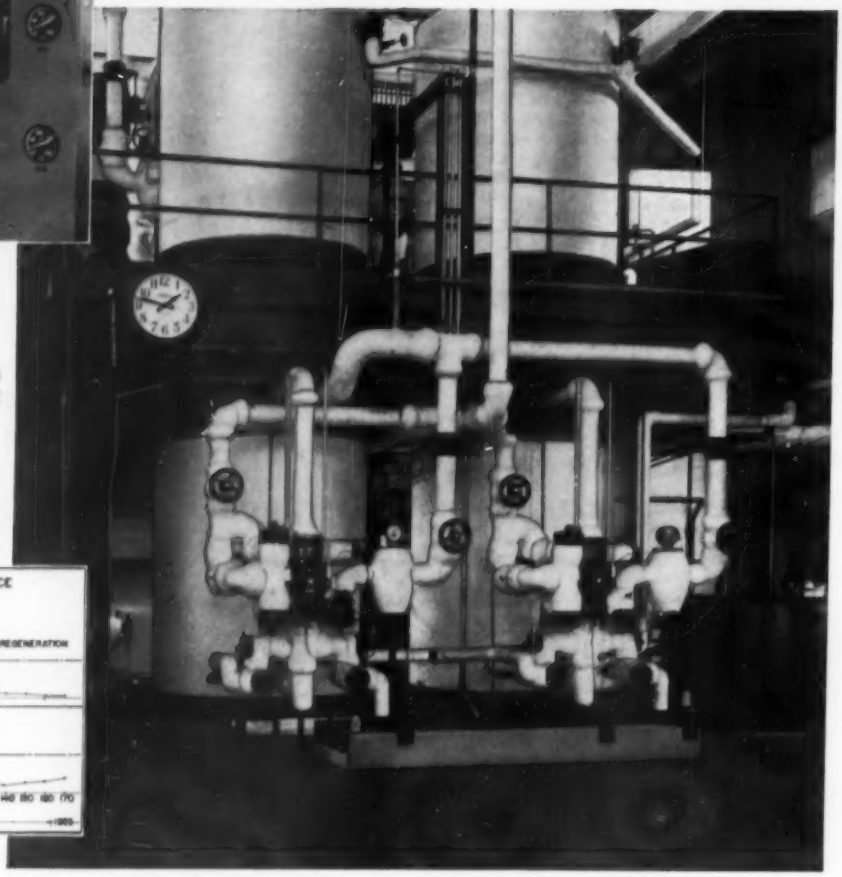
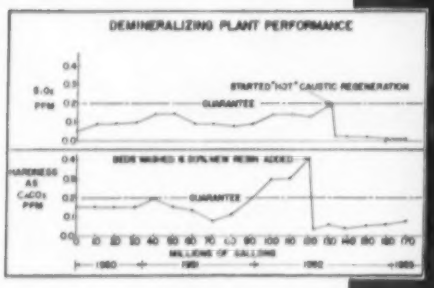


Waukegan Station Demineralization Plant

"CATEXER" "ANEXER" Demineralization Plant performance charts at Waukegan Station.



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With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

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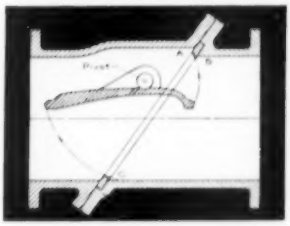
Never a Flutter, Never a Slam!

Designed and Built for Quiet Efficient Operation



In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

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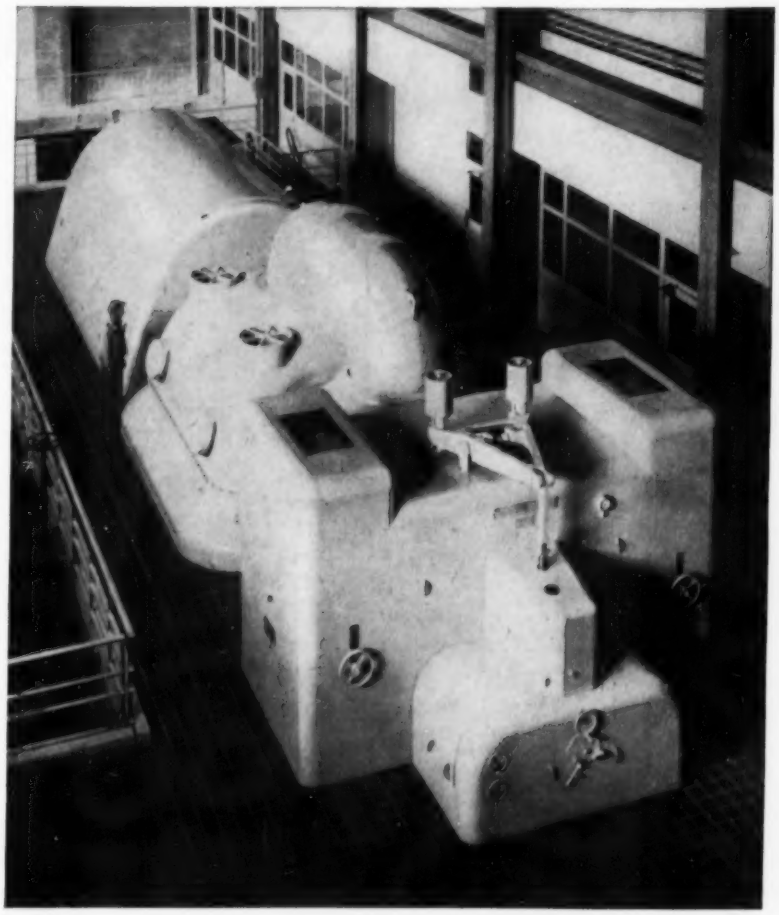

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